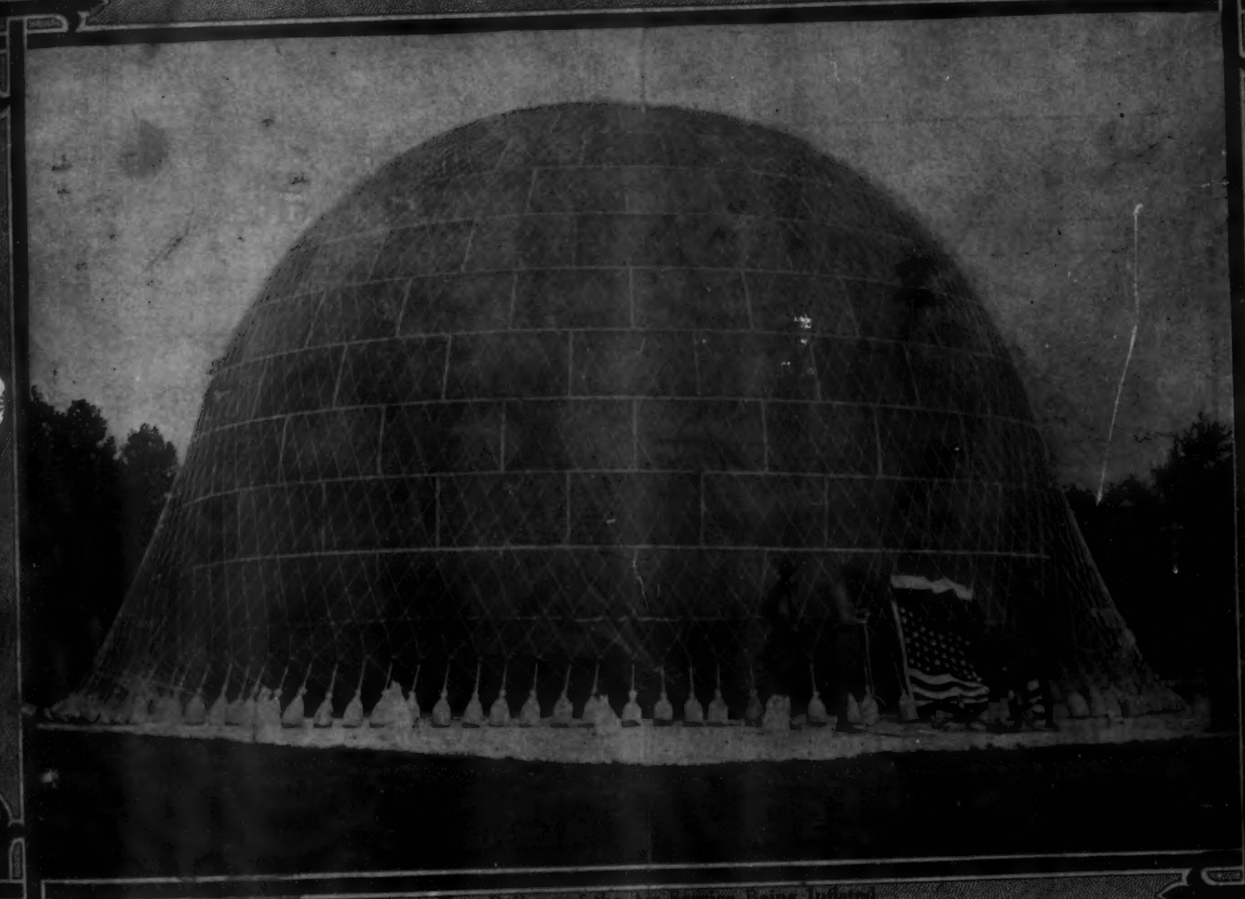
RUARY 1, 1919 PRICE 25 CENTS

AVIATION AND AERONAUTICAL ENGINEERING



Free Balloon of the Air Service Being Inflated
(C) International Film Service

VOLUME VI
Number 1

Three Dollars a Year

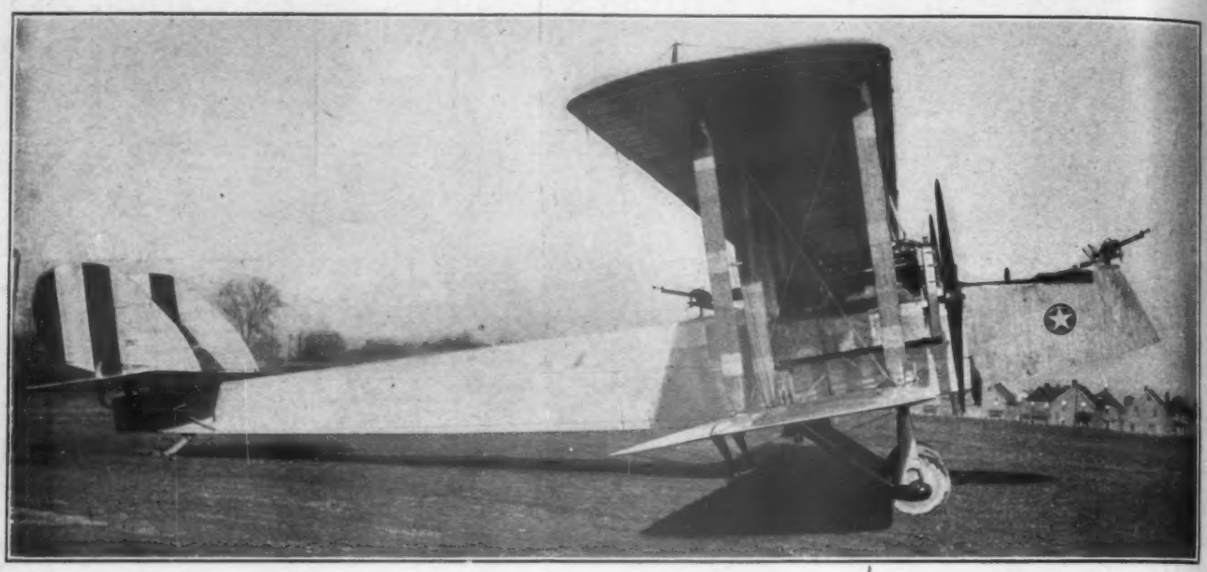
SPECIAL FEATURES

SELECTING AEROFOILS FOR SPEED RANGE
THE 300 HP. HISPANO-SUIZA ENGINE
THE AIRSHIP FOR COMMERCIAL PURPOSES
THE NAVAL AIRCRAFT FACTORY
THE BIJUR AIRPLANE ENGINE STARTER

PUBLISHED SEMI-MONTHLY
BY
THE GARDNER-MOFFAT CO., INC.
HARTFORD BUILDING, UNION SQUARE
22 EAST SEVENTEENTH STREET, NEW YORK

Entered as second-class matter, August 4, 1916, at the Post Office at New York, N. Y., under act of March 3, 1879

AUTHORIZED



THE MARTIN NIGHT BOMBER

THE MOST IMPORTANT AERIAL DEVELOPMENT OF THE WAR

Officially, it has surpassed the performance of every competitor.

The forerunner of the wonderful

AERIAL FREIGHTER *and* TWELVE PASSENGER AIRPLANE

The skill and ability of the HOUSE OF MARTIN continue to maintain Supremacy of Performance and Dependability which they have held since 1909.

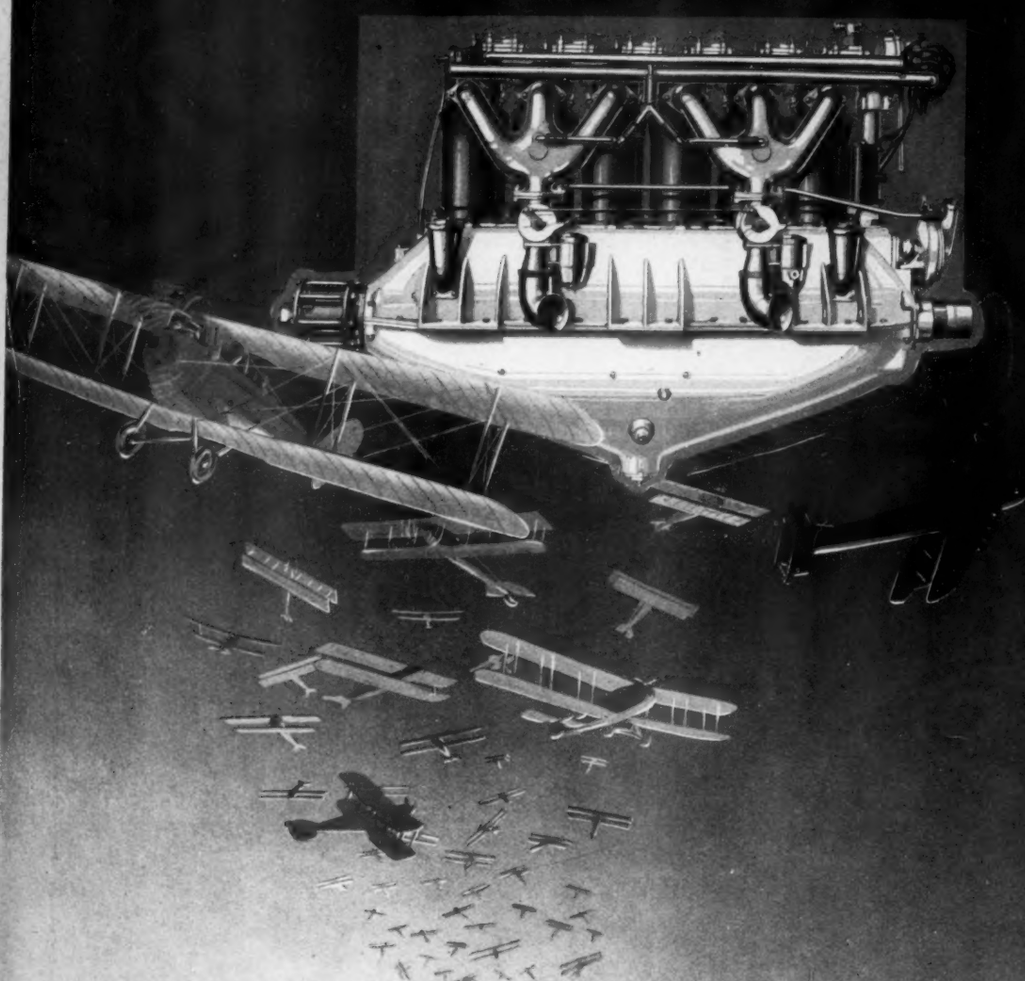
MARTIN U.S.A.

THE GLENN L. MARTIN COMPANY

CLEVELAND

Contractors to the United States Government

HALL-SCOTT



Hall-Scott L-6 Engine
Shows Remarkable Test Record

In test runs at the Dayton Engineering Laboratories (Delco) with a Hall-Scott, six cylinder, L-6 Airplane Engine, the average b. h. p. developed was 212.6 at 1666 r. p. m. This engine weighed on the test stand, 502 lbs., or 2.45 lbs. per b. h. p.

The well known Hall-Scott type A-5 Engine, rated at 125 h. p., weight 4.12 lbs. per b. h. p., is still a successful product. The L-6 is a fighting job showing marked development advance.

Circular on request.

HALL-SCOTT MOTOR CAR COMPANY
Crocker Building, San Francisco

PROPERTY U. S. AIR FORCE

·L·W·F·ENGINEERING·COMPANY Inc.
COLLEGE POINT. N. Y.

THE ANNUAL

Aeronautical Exposition

OF THE

Manufacturers Aircraft Association

INCORPORATED

WILL BE HELD

MARCH 1st to MARCH 15th

IN

Madison Square Garden, and the 69th Regiment Armory, New York City

AMERICA THE PIONEER IN AERONAUTICS
IS CHALLENGED BY THE WORLD

This Exposition

Will illustrate
What American Industry is Doing to Keep
Our Flag in the Skies

For further information address:

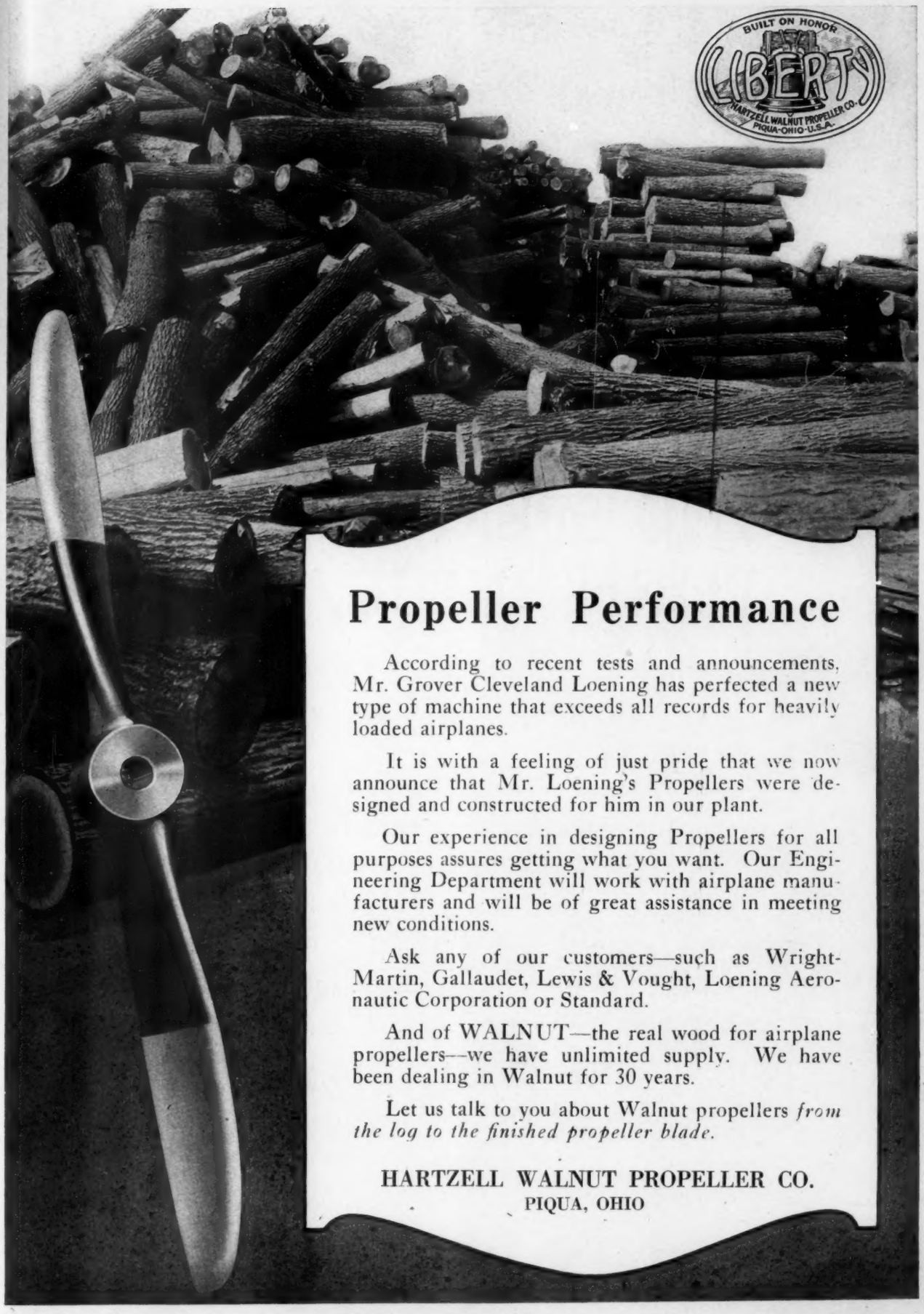
SHOW COMMITTEE

MANUFACTURERS AIRCRAFT ASSOCIATION

501 Fifth Avenue NEW YORK CITY

That the services of the United Aircraft Engineering Corporation may be of the greatest possible value to the upbuilding of the industry this firm is rapidly adding to its organization personnel those names which are best known for definite aircraft engineering accomplishment

52 Vanderbilt Ave.
NEW YORK



Propeller Performance

According to recent tests and announcements, Mr. Grover Cleveland Loening has perfected a new type of machine that exceeds all records for heavily loaded airplanes.

It is with a feeling of just pride that we now announce that Mr. Loening's Propellers were designed and constructed for him in our plant.

Our experience in designing Propellers for all purposes assures getting what you want. Our Engineering Department will work with airplane manufacturers and will be of great assistance in meeting new conditions.

Ask any of our customers—such as Wright-Martin, Gallaudet, Lewis & Vought, Loening Aeronautic Corporation or Standard.

And of WALNUT—the real wood for airplane propellers—we have unlimited supply. We have been dealing in Walnut for 30 years.

Let us talk to you about Walnut propellers *from the log to the finished propeller blade.*

HARTZELL WALNUT PROPELLER CO.
PIQUA, OHIO

Major General George O. Squier says: "A reliable and simple 'turning indicator' is much needed."
—Address before the A.I.E.E. Jan. 10th, 1919.

Here it is!

THE SPERRY GYRO TURN INDICATOR

It shows instantly any departure from straight-line flight, is very simple in construction and reliable in operation. Can be quickly installed on any instrument board. Weight, complete, one and three-quarter pounds. Write for full information.

THE SPERRY GYROSCOPE COMPANY

Manhattan Bridge Plaza, Brooklyn, New York

The Pledge on the Post Office Portico

"Neither snow nor rain nor hail nor gloom of night shall stop these couriers from the swift completion of their appointed rounds."

This is the promise carved on the portico of the New York Post Office—a promise that has become fact in the case of the air-mail as it is in the case of other postal departments.

For months six postal-planes, specially designed and built by the Standard Aircraft Corporation, have carried the mail between New York and Washington with a regularity equaling, if not surpassing, that of the railroads.

Truly a new era in transportation is at hand.

Member of Manufacturers' Aircraft Association, Inc.

STANDARD AIRCRAFT CORPORATION

ELIZABETH NEW JERSEY

NEW ENDURANCE RECORD

Established by

Union Airplane Motor at U. S. Aeronautical Testing Laboratory, Navy Yard, Washington, D. C.

Best previous record exceeded by fifty per cent.

UNION GAS ENGINE COMPANY

ESTABLISHED 1885

OAKLAND - - - CALIFORNIA

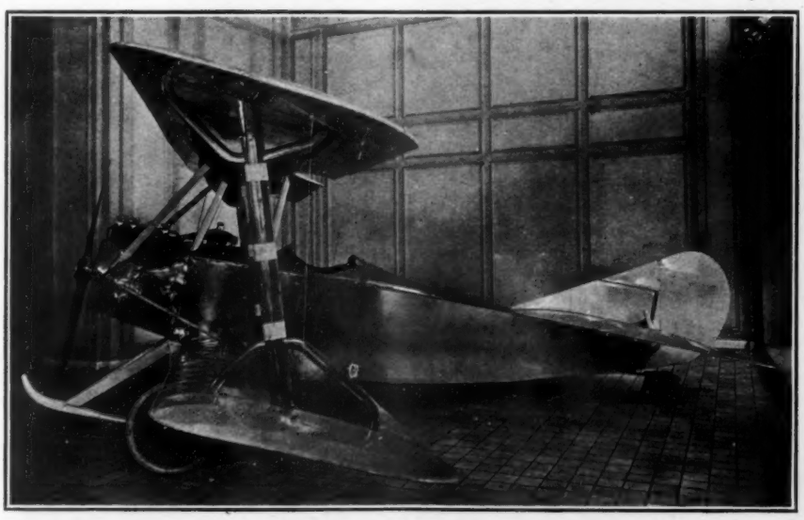
IT IS AN

ACE

and ready for immediate delivery

$2500

Low in the cost of up-keep



High in the factor of safety

A PRACTICAL AIRPLANE

Built by an organization skilled in aircraft design; for the man who loves the air regardless of the business that calls him. Ideal for the ranch owner, the pilot of the aero mail, the sportsman and the explorer. Sturdy in construction, capable of long and continued service.

"The Country Road Your Airdrome"

AIRCRAFT ENGINEERING CORPORATION

C. M. SWIFT, General Manager - - 2 East End Avenue
N. W. DALTON, Chief Engineer - - - 2 East End Avenue
HORACE KEANE, Sales Manager - - 220 West 42nd Street

NEW YORK

Contractors to the United States Government

BOEING AIRPLANE COMPANY

AIRPLANES
SEAPLANES
FLYING BOATS

BOEING
SEATTLE

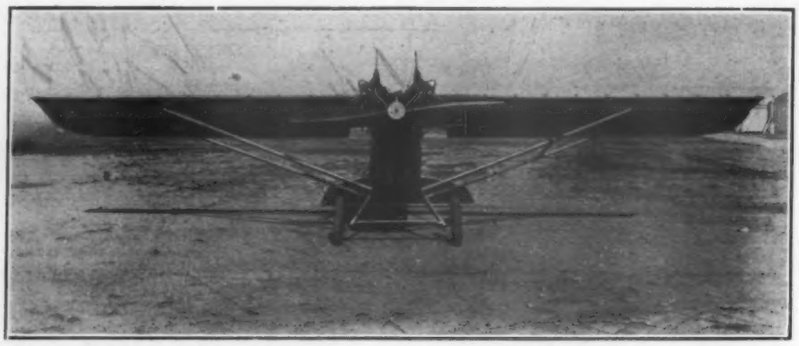
FOR COMMERCIAL
AND SPORTING
PURPOSES

Contractors to U. S. Navy

Unexcelled in Design, Workmanship and Reliability

GEORGETOWN STATION SEATTLE, WASH.

GOODYEAR
AKRON



THE RECORD BREAKING LOENING MONOPLANE—THE WORLD'S FASTEST SUCCESSFUL TWO-SEATER.

Designed and constructed by Grover C. Loening for the Wright-Martin Aircraft Corp., and subsequently taken over by the U. S. Army Air Service.

GROVER C. LOENING, B.Sc., A.M., C.E.

Consulting Engineer

Announces the establishment of the new laboratory of the Loening Aeronautical Engineering Corp.

at

351 West 52d Street

NEW YORK CITY

With complete and efficient facilities for the study, development and construction of new types of aeroplanes.

Criss-Crossed in every direction

NOTE the interwoven or cloth-like appearance of the structure in this micro-photograph. By reason of the exclusive process employed in alloying Non-Gran Bronze, this fibrous, crystalline structure results, requiring a greater degree or duration of frictional pull to produce destructive wear.

Our entire production resources are devoted to this one alloy — Non-Gran. Production is maintained under the inflexible policy of *one formula, one method, one result.*

This is a factor of vital importance in the selection of a bearing bronze. Even though the bronze you are using *today* may be satisfactory, what assurance have you that *tomorrow's* shipment will be likewise, if produced by a foundry making a number of *different* alloys?

The present era is one of specialization. Non-Gran is produced by specialists. Its unvarying dependability is the same today as years ago, and the same tomorrow as years hence.

In our new plant the latest devices and equipment have been installed to further reduce the element of human fallibility in maintaining the uniformity of Non-Gran Bronze.

The term "Non-Gran" symbolizes

A reputation made by quality maintained by uniformity

HIGH SPEED NON-GRAN BEARING BRONZE

American Bronze Corporation

Berwyn Pennsylvania

VENUS PENCILS

THE day may not be distant when a plane will fly around the world. In every civilized center its pilot will find the famous VENUS Pencils, supreme for map drawing or any other technical, exacting work.

17 black degrees

For bold heavy lines
6B-5B-4B-3B

For general writing and sketching
2B-B-HB-F-H

For clean fine lines
2H-3H-4H-5H-6H

For delicate thin lines, maps
7H-8H-9H

Special 14c. Offer

Send 14 cents for 3 trial samples, mentioning degrees. After you find how perfect VENUS Pencils are, buy them at any dealer.

Of all stationers and stores throughout the world.

American Lead Pencil Company
242 Fifth Avenue, New York
and Clapton, London, Eng.

It has doubled the usefulness of the Clock and the Watch.

It has made Night-flying safe because the aviator can see every one of his instruments in the dark.

It has safe-guarded our Ships because the navigator can always see his Telegraph, Compass and other instruments on the blackest night, without lights.

It has added an element of Safety to Automobiling and Motor Boating at night, every instrument from the oil gauge to the ammeter being distinctly visible at all times.

It provides a light that cannot go out, *and manufacturers of all kinds of instruments are constantly finding new uses for it.*

MARVELITE

is made with Radium from our own mines in Colorado. It can be applied economically to anything that must be seen in the dark, and lasts for many years.

Booklet "A" tells all about it.

COLD LIGHT MFG. CO.
50 Union Square New York

FEBRUARY 1, 1919

AVIATION AND AERONAUTICAL ENGINEERING

VOL. VI. NO. 1

Member of the Audit Bureau of Circulations

INDEX TO CONTENTS

	PAGE
Editorials	19
Selecting Aerofoil Sections for Speed Range	20
Aircraft Instruments for "Blind" Flying	22
The Model H, 300 Hp. Hispano-Suiza Engine	23
The Airship for Commercial Purposes	27
The Naval Aircraft Factory	28
The Miller 125 Hp., Aircraft Engine	30
Commercial Transport by Airplane	31
The Bijur Airplane Engine Starter	33
Aeromarine Flying Boat, Sportsman Model	34
Organization of Aerial Ports	35
The Fokker-Junkers Armored Airplane	36
Canada's Aircraft Industry During the War	37
Standardized Magnetos for Aircraft Engines	38

THE GARDNER - MOFFAT COMPANY, Inc., *Publishers*

HARTFORD BUILDING, UNION SQUARE, 22 EAST SEVENTEENTH STREET, NEW YORK

WASHINGTON OFFICE, EVENING STAR BUILDING

SUBSCRIPTION PRICE: THREE DOLLARS PER YEAR. SINGLE COPIES TWENTY-FIVE CENTS. CANADA, THREE AND A HALF DOLLARS: FOREIGN, FOUR DOLLARS A YEAR. COPYRIGHT 1919, BY THE GARDNER-MOFFAT COMPANY, INC

ISSUED ON THE FIRST AND FIFTEENTH OF EACH MONTH FORMS CLOSE FIVE DAYS PREVIOUSLY. ENTERED AS SECOND-CLASS MATTER, AUGUST 3, 1916, AT THE POST OFFICE AT NEW YORK, N. Y., UNDER ACT OF MARCH 3, 1879.

1919?

What the coming year has in store for American Industry is the question in the mind of every business man. The answer depends entirely upon ourselves.

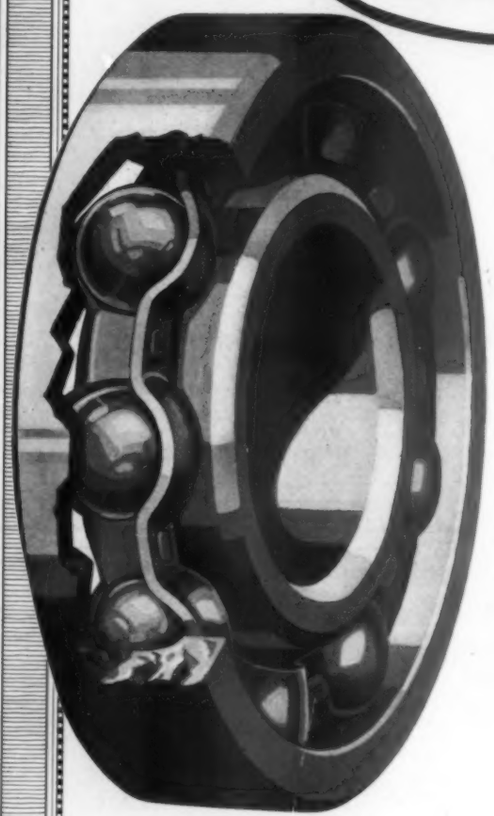
A forward look and immediate action are necessary. The man that fears radical readjustments and declining prices and selfishly waits to get the full benefit of these will be left behind in the commercial race. If all should do this, it would mean disaster. Fair wages and fair prices mean prosperity. There is an ample market for all our products at their present values. We must translate our belief in the future into purchasing and production if we are to be ready for the rising tide of business.

If we do this and suit our actions to our words there can be no doubt as to the answer of the question—What of 1919? The Automotive Industry proved its ability and patriotism during the War. It now has the opportunity to prove its strength, permanence and commanding position among the Industries of America.

Wyman-Gordon Company

Worcester, Mass. Cleveland, Ohio

Quality



MAGNETO TYPE.

A ball bearing that most truly is built like a watch, small in size, exquisite in the precision of its every part and detail, and so designed as to be specially adaptable to noiseless running at high speeds.

Its worth has been clearly demonstrated by its choice in the large majority of high grade apparatus in both the automotive and general machinery trade.

Special Engineering Data Sheets, showing the application of this efficient ball bearing to all types of machinery will be gladly furnished upon request.

The New Departure Manufacturing Company,
Bristol, Conn. 406 Detroit, Mich.

Conrad Patent Licensee.

New Departure Ball Bearings

L. D. GARDNER
PRESIDENT AND EDITOR
W. D. MOFFAT
VICE-PRESIDENT
W. I. SEAMAN
TREASURER
H. M. WILLIAMS
GENERAL MANAGER

AVIATION AND AERONAUTICAL ENGINEERING

ALEXANDER KLEMIN
TECHNICAL EDITOR
LADISLAS D'ORCY
ASSOCIATE EDITOR
GEORGE NEWBOLD
BUSINESS MANAGER

Vol. VI | February 1, 1919 | No. 1

THERE are printed in the present issue excerpts from technical reports submitted by special subcommittees to the British Committee on Civil Aerial Transport, to which particular attention is invited.

These reports possess considerable value as elucidating some of the complex questions that arise in connection with the establishment of commercial aeronautics, the more so as they represent the opinions of a large number of authoritative men possessing scientific, technical, manufacturing, and practical experience in aeronautics.

It is interesting to note the emphasis which is placed in the British report upon the commercial future of the airship, particularly as a long distance carrier of passengers, goods, and mails. This subject is treated very comprehensively by Wing Captain Maitland, R.N. —one of the earliest British airship pioneers—in a report which is printed in this issue in extenso.

This report as well as sundry information that has recently reached this country from abroad bear out the fact that Great Britain fully grasps the great possibilities the airship presents for heavy weight transportation at a high rate of speed over distances exceeding 1,000 miles at a stretch. Thus it is announced that nine airship stations and a number of naval airships will shortly be made available for civilian uses by the British Admiralty. That this preliminary step foreshadows extended action with respect to the establishment of British commercial airship services cannot be doubted for a moment, particularly in view of the fact that Great Britain has, unlike her Allies, never considered Germany's Zeppelin activity as sheer folly, but has, on the contrary, recognized her own shortcomings in these craft in connection with naval warfare, and has, since the war, expended considerable efforts for overcoming Germany's lead in this field. That these endeavors have been crowned with success is proven by the performances of the most recent British naval airships of rigid type, which have a cruising endurance of over 200 hours. The possibilities such a craft holds forth for commercial purposes are obvious.

Germany, of course, has for the last twenty years been the indefatigable champion of the airship, and has persisted in this attitude entirely regardless of most stupendous failures, all of which have by the way advanced the science of airship construction. The latest developments in this field—in particular, the successful production of a non-inflammable lifting gas, helium, by American chemists—show that Germany was not unjustified in maintaining her faith in the airship, and specifically in the rigid type.

The performances of passenger Zeppelin lines which were operating between various German cities from 1910 to 1914 gave the first indication of the commercial possibilities of the rigid airship. It is true that these services were heavily subsidized by the German Government, which had an obvious interest in developing this type of aircraft, but even so the record of these services was remarkable enough in that no Zeppelin passenger ever lost his life in a trip, although several of the airships were lost owing to various causes.

Little surprise is therefore caused by press reports announcing that the Zeppelin works at Staaken are engaged in building a commercial airship destined for trans-Atlantic service which will have accommodation for 100 passengers and 45 tons of mail and baggage. It is planned to build a fleet of twelve ships of this type, of which eight will be for actual service, while four will be kept in reserve. While these plans are naturally conditional upon the peace terms that will be imposed upon Germany, they nevertheless give a remarkable indication of how even a defeated nation can work for the future of commercial aeronautics.

Now it seems that if a defeated Germany can entertain such ambitious plans for capturing the world's coming air-borne trade, the United States, which has come out victorious of the great World War, should at least contribute its share to the creation of rapid transportation services by means of airships.

Of course, the difficulties which will have to be overcome in this country in an endeavor to create a satisfactory type of rigid airship should by no means be underrated. Germany has an advance of some fifteen years in this field over the rest of the world, with the sole exception of Great Britain, which comes a close second owing to the extraordinary efforts she has made during the war to make up in the shortest possible time for past errors. Thus, there are today two countries which possess types of airships which are entirely adequate for inaugurating regular passenger services over long distances—Great Britain and Germany.

Neither France, nor Italy, nor the United States have any type of airship that could successfully compete with the large rigid vessels of the British and the Germans.

In view of the geographical position and topography of this country as well as of its legitimate interests in South America and the Pacific it is urgent that steps be taken at once in order to create—if need be, with Government assistance—an American commercial airship fleet. In this matter time is precious, for every day lost increases the supremacy the foreign airship fleets will possess in carrying the air-borne trade from and to these shores and make our efforts at overcoming our shortcomings proportionally more difficult.

Selecting Aerofoil Sections for Speed Range

By Lieut.-Col. V. E. Clark, A. S.

The accompanying charts were developed to serve as a "rough and ready" means of choosing the best aerofoil section for speed range. Incidentally, the charts serve to roughly estimate the speed performance to be expected in a given airplane.

In plotting these charts it has been assumed always that the airplane is a single-engine, biplane tractor of good aerodynamic design, with full military equipment installed. Sea level values of air density, horsepower and air speeds are assumed throughout.

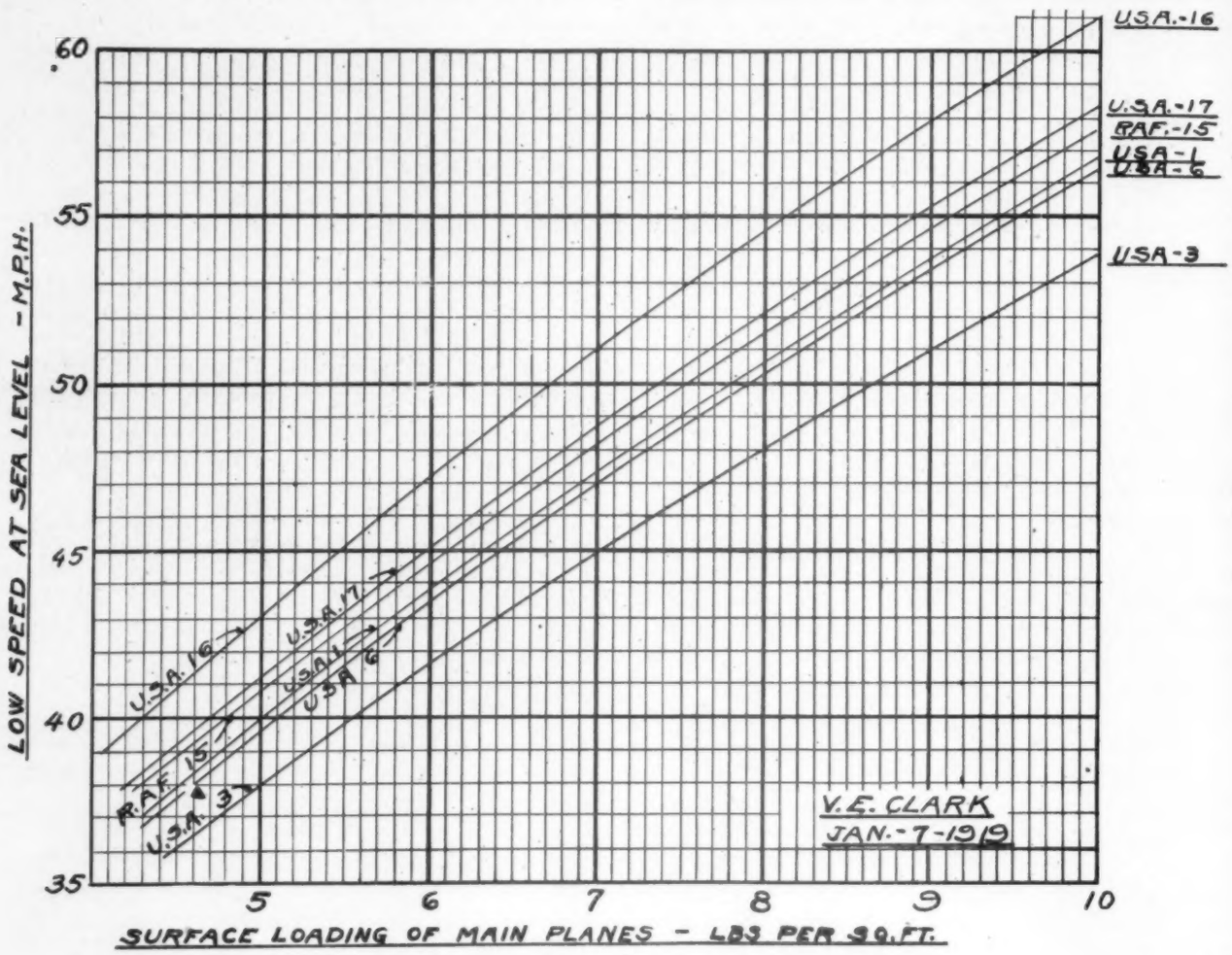


FIG. 1

In Fig. 2 the three curves (I) indicate the air speed range to be expected for various values of power loading and surface loading. That is, they are meant to show the speed range (high speed in percentage of low speed) plotted against values of hp./weight in lb.

Curve (II) represents the value of air speed required for sustentation (in percentage of minimum air speed); plotted against percentages of maximum value of lift coefficient K_y. Because of the form of the equation

$$\text{Weight} = \text{Lift} = K_y S V^2$$

(K_y for sea level density),

this curve is a parabola, with its asymptote at the abscissa at value zero percentage of maximum K_y.

Curves (III) represent values of K_y/K_x or L/D for six known aerofoils, plotted against per cent of maximum K_y. The values in these curves have been corrected, as accurately as possible, for full scale and speed, biplane with 17 per cent stagger, gap/chord ratio 1.06 (for which biplane combination considerable experimental data is available), aspect ratio 7, rounded wing tips, etc. The angles of incidence indicated by points along the curves are those above the angle of zero lift.

On the chart Fig. 1 are plotted curves for the same aerofoils, of the minimum speed at sea level (in m.p.h.) to be expected for various values of the surface loading of the main planes in pounds per square foot. These curves have been corrected for full scale and speed, biplane arrangement as above, etc.

Method of Using Charts

Suppose we have in mind for design, or are presented with a design, in which an engine with a given hp. is contemplated, the total weight of the airplane is stated, and the total area of the main sustaining surfaces.

Enter Fig. 2 at the top line for the value of hp./weight in lb. Drop vertically until we intersect Curve (I) for the value of the wing loading in lb. per sq. ft. Interpolation or extrapolation is usually necessary. Then horizontally across until we intersect Curve (II); then vertically until we intersect the L/D curves. The aerofoil which gives the best value of L/D in this region is evidently the aerofoil section which will give the maximum speed range for the airplane with the characteristics assumed.

Example 1—Suppose we have a single-engine, tractor bi-

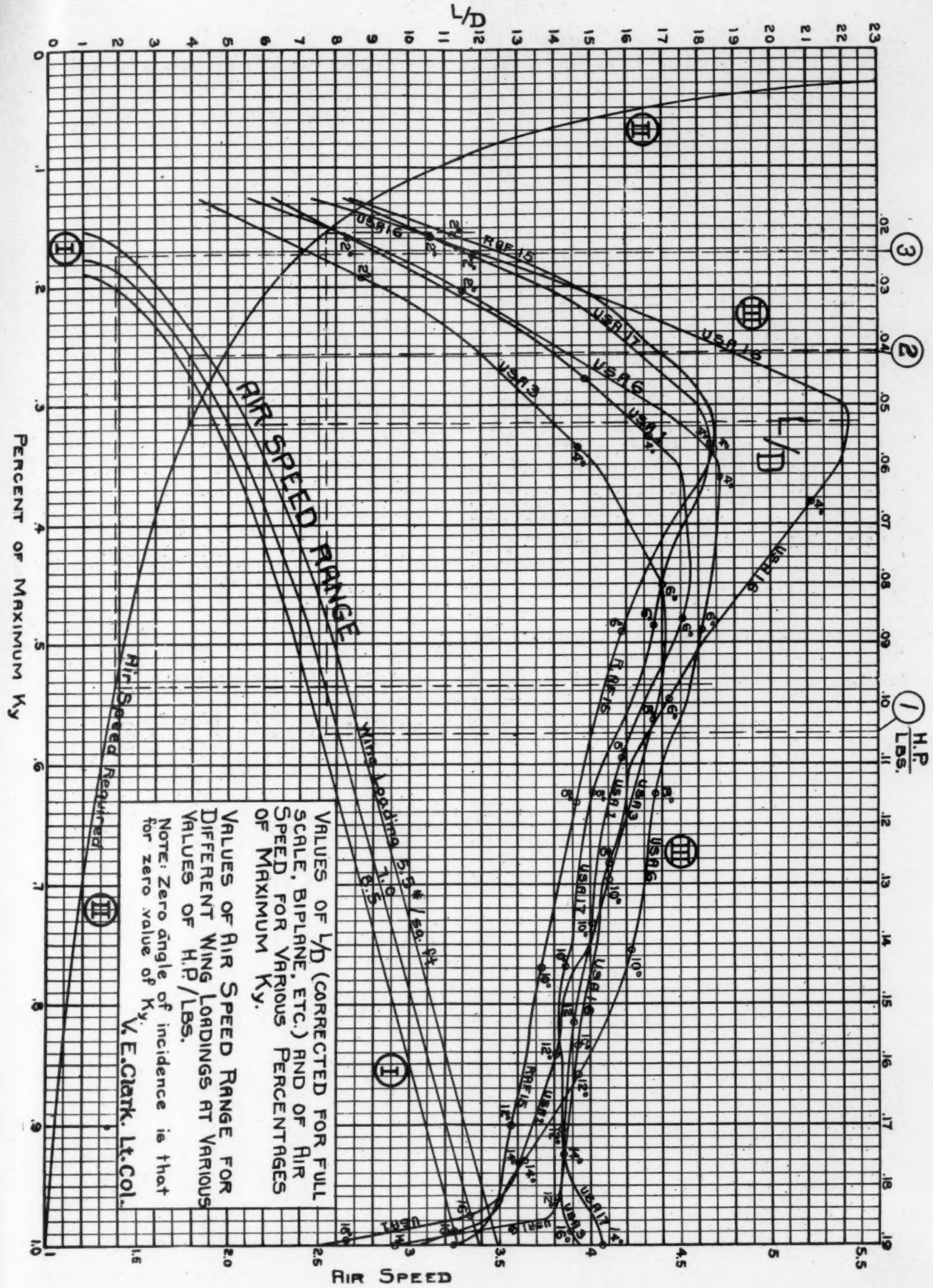

L/D
H.P. / Lbs.
Air Speed
Percent of Maximum Ky
AIR SPEED RANGE
Air Speed Required
USA16
USA17
USA6
USA3
USA1
USA2
USA4
USA5
USA7
USA8
USA9
USA10
USA11
USA12
USA13
USA14
USA15
Ref 15
Wing Loading 5.9 #/sq. ft
7.0
8.5
VALUES OF L/D (CORRECTED FOR FULL SCALE, BIPLANE, ETC.) AND OF AIR SPEED FOR VARIOUS PERCENTAGES OF MAXIMUM Ky.
VALUES OF AIR SPEED RANGE FOR DIFFERENT WING LOADINGS AT VARIOUS VALUES OF H.P./LBS.
NOTE: Zero angle of incidence is that for zero value of Ky.
V. E. Clark. Lt. Col.

FIG. 2

plane whose engine will develop 300 hp. at sea level; whose total weight we estimate to be 2855 lb.; and the area of whose main sustaining surfaces is 357 sq. ft. The value of hp./lb. is .105. The surface loading is 8 lb. per square foot. Following the dotted line shown in Fig. 2 we find that the best aerofoil, if speed range is the primary requirement, is the R.A.F.-15. The value of L/D for the high speed condition for the wings alone is 7.7. Incidentally, the speed range indicated is 2.54.

Referring to Fig. 2, it appears that, for the R.A.F.-15, for a surface loading of 8 lb. per sq. ft., the minimum air speed at sea level is 51.5 m.p.h. The speed range being 2.54, the high speed should be at least 130.75 m.p.h.

Example 2—Assume hp. at sea level 300; total weight of airplane 7230 lb.; total area of main sustaining surfaces 1033 sq. ft. The value of hp./lb. = .0115. Enter Fig. 2 and follow the dotted line (2). We find that the USA-16 is the best aerofoil for speed range. A value of 22.2 for L/D for the high speed condition is indicated. The speed range is 1.78. Fig. 1 indicates that, for a loading of 7 lb. per sq. ft., the USA-16 will permit a slow speed of 51 m.p.h. at sea level. The high speed is evidently 90.7 m.p.h. This machine is entirely practicable for some commercial purposes, as the absolute ceiling should be over 8500 ft., and the rate of climb at sea level 280 ft. per minute.

Example 3—Assume hp. 300; total weight 12,250 lb.; total area of main sustaining surfaces 2042. The value of hp./lb. is .0245. Entering the chart (Fig. 2) and following the dotted line (3), we find that for such a theoretical machine, the USA-6 would be the most efficient. The value of L/D for the high speed conditions would be 17.8. Fig. 1 shows the slow speed to be 43.5 m.p.h. The speed range being 1.375, the high speed would be 59.8 m.p.h. We have selected the values assumed in example (3) because they represent the absolute limit for a flying machine of the general type mentioned above. For a surface loading of 6 lb. per sq.ft., the machine whose value of hp./lb. is .0245, is flying "tangent" in air of the standard density at sea level. Such a machine would, theoretically, skim along the surface supporting its own weight, but would not rise.

The chart (Fig. 2) also serves to indicate to permissible limit for parasite resistance. For instance, in example (1) let

V = Air speed in miles per hour
L = Lift of main sustaining surfaces in lb.
D = Drag of main sustaining surfaces in lb.
W = Total weight of airplane in lb.
P = Brake hp. at sea level
p = hp. delivered by propeller
T = Thrust of propeller in lb.
R = Parasite resistance in lb.

Example (1)

$R = T - D$

$D = L/7.7 = W/7.7 = 371$ lb.

$T = 375\ p/V$

(550 lb.-ft.-sec. $\times$ speed in m.p.h./speed in ft. per sec. = 375)

Assuming propeller efficiency 80 per cent.

$p = .8 \quad P = .8 \times 300 = 240$ hp.

$T = 375 \times 240/130.75 = 688$ lb.

$R = T - D = 688 - 371 = 317$ lb.

$R = .0185V^2$

By the same method, in example (2), the value of parasite resistance must not exceed $.081V^2$; and in example (3) R must not exceed $.229V^2$.

It will be noted that should climbing ability be an important requirement, the USA-6 is the best aerofoil of the group considered. It gives the best values of L/D between the speed range (per cent of minimum speed) 1.07 and 1.41.

The USA-6 is also the best if great radius of action is important, as it should give the best economy in quantity of fuel consumed per mile for any except a very high speed range machine. The USA-16 should be the best for economy for a very high speed range machine.

It is Colonel Clark's intention that these charts should not be taken as mathematically accurate. It would be impossible to treat in such fashion the prediction of performance. It is, however, based on a careful study of current practice in the tests of numerous machines, and is a very reliable guide in the selection of a wing section. It is interesting to note that Lieutenant-Colonel Clark is responsible for the development of the widely known and used U. S. A. aerofoils, some of which have been described in these pages.—Ed.

Aircraft Instruments for "Blind" Flying

Flying in fog, clouds or darkness—which may be called "blind flying"—involves difficulties not encountered in clear air. It is not possible to maintain the proper attitude of the machine longitudinally, laterally nor in respect to a desired course without the use of instruments.

Longitudinally, the air-speed indicator, particularly when used in conjunction with the tachometer, serves to indicate to the pilot his correct attitude. That is, with engine speed normal, an increase in air speed indicates a descent, while a decrease in air speed indicates a climb. The altimeter has too slow an action to be of value except to check the climb or descent of the machine over definite periods.

Laterally and directionally, there have heretofore been no instruments giving any assistance except the banking indicator and lateral clinometer, and the compass. As the banking indicator and lateral clinometer indicate divergence from a stable lateral position but do not show a departure from the lateral horizontal, their use is very limited. That is, although an airplane might be banked steeply and turning rapidly a banking indicator or lateral clinometer would give no indication providing the ship was neither skidding nor side slipping.

When a machine is flying straight the course may be determined quite accurately from a compass. The compass will not, however, indicate accurately when the ship is turning and is not dependable for quite an interval after straight flight is is resumed. This interval depends upon the speed and duration of the turn and also upon the type of compass.

It is therefore apparent that a "turn indicator" which would accurately and instantly indicate any divergence from a straight course would also serve to indicate departures from the lateral horizontal, and consequently solve the problem of fog, cloud or night flying. For, if by the use of this instrument a straight course can be maintained, the compass can be depended upon for showing the desired direction, while the longitudinal attitude can be controlled by the combined use of the air-speed indicator, tachometer and altimeter.

With a view to solving this problem there has recently been developed an instrument which promises to mark a decided advance in making "blind" flying comparatively safe: this is the Gyro Turn Indicator, which is produced by Sperry Gyroscope Co., of Brooklyn, N. Y.

The mechanism of this instrument is extremely simple. A small gyro, on a lateral axis, is spun to about 5000 r.p.m. by the suction obtained from a venturi tube placed in the air stream and connected to the instrument by a length of tubing. The frame holding the gyro bearings is hung on a fore and aft axis, but its rotation about this axis is restrained by light centralizing springs.

The action of the instrument depends upon the well-known law of gyroscopic precession—that is, any rotary motion transmitted to a gyro (except motion about its own axis) causes the gyro to move, not in the direction of the applied motion, but at right angles to it. This motion at right angles to the applied motion is called "precession." Furthermore, the speed at which a gyro will "precess" is many times greater than the speed at which the rotary motion is applied to it.

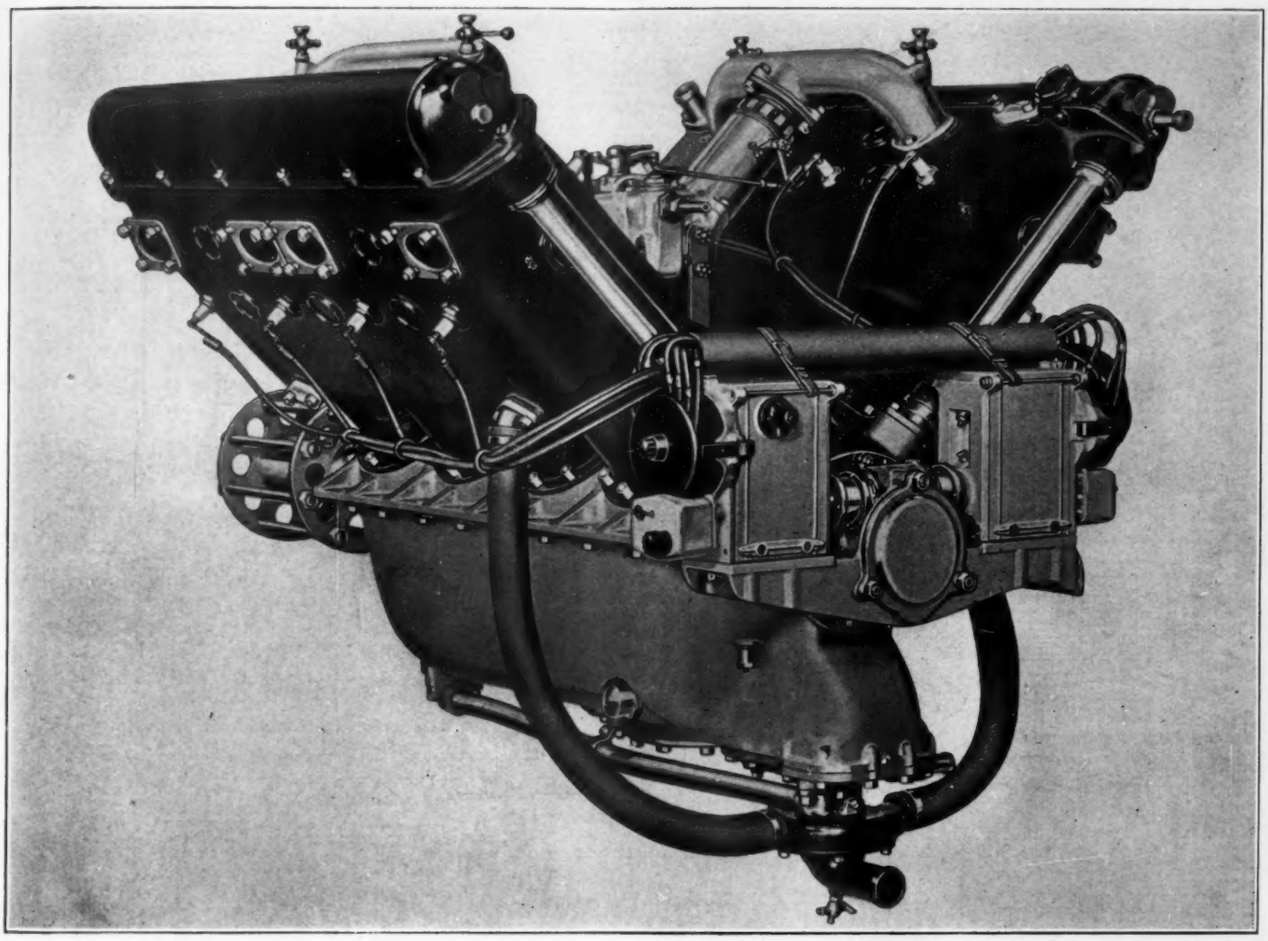
The operation of the indicator is thus very simple. When the airplane starts to turn (about a vertical axis) the rotary motion causes the gyro to precess (about a horizontal axis) and this precession, many times greater than the turning motion of the airplane, is indicated on the dial of the instrument.

The Gyro Turn Indicator, complete with a venturi tube for operation, weighs but 1.75 lb. The power required to operate the instrument is no more than that needed for an air speed indicator.

The Model H, 300 h.p., Hispano-Suiza Engine

Rated at 300 hp. at 1,650 r.p.m. the Model H is the most powerful of the series of Hispano-Suiza engines. In its general lines this engine is very similar to the Model I, which was described in the Dec. 1, 1918, issue of AVIATION AND AERONAUTICAL ENGINEERING; the description which follows deals therefore mainly with the points in which the Model H differs from the other Hispano-Suiza engines, and particularly with regard to lubrication.

The Model H engine is of the water-cooled V-type, with eight cylinders arranged in two blocks of four at an included angle of 90 deg. The bore is 140 mm (5.511 in.) and the stroke, 150 mm. (5.905 in.) The engine weighs, complete with carburetor and magnetos, 600 lb.



THREE-QUARTER VIEW FROM MAGNETO END

Cylinders

The cylinders are separate steel sleeves, flanged at the bottom for attachment to the crankcase, and with flat steel heads in which the valve seatings are cut. These sleeves are threaded for almost their entire length and are screwed into an aluminum water jacket which carries the valves and the camshaft. The resulting effect of this construction is to provide an aluminum cylinder block completely lined with steel.

All stresses within the cylinders are transferred directly to the crankshaft and crankcase through the steel sleeves, the aluminum having only to carry the camshaft, and this means that the cylinder block is very strong while being very light in weight. The cylinder block is enameled inside and out protecting the aluminum from corrosion due to impurities in the cooling water or in the atmosphere.

Valves and Valve Gear

The valve seatings are cut in the steel heads of the cylinder sleeves and the valve stems project vertically upward through cast iron guides screwed into bosses in the aluminum. A flat tappet of mushroom form is attached directly to the upper end of each valve stem.

The detail of the tappet adjustment is one of the most ingenious features of the engine. The valve stems are of large diameter and are hollow, being threaded internally. The tappet has a flat head with a notched edge and its underside is serrated, the top surface, on which the cam bears, being casehardened. The stem of the tappet screws deeply into the hollow valve stem.

Beneath each tappet there is a washer with fine serrations which mesh with those on the underside of the tappet. The hole in the center of the washer is not circular, but there are two projecting pieces which fit in slots cut in the top end of the valve stem and around the periphery of this washer are a number of small holes. The valve springs, of which there are two to each valve, one inside the other, come immediately beneath the washer and hold it up against the tappet. Now, owing to the washer fitting into the slots in the valve stem, it cannot turn on the valve and if the washer is held the tappet can be turned, the serrations between the two "clicking" over each other and yet having grip enough to securely lock the tappet. A special wrench is used for this adjustment which can be performed with great ease and quickness.

The camshaft is mounted in three bronze bearings bolted to the top of the cylinder block, so that the cams act directly upon the tappets without any intermediate mechanism. Camshaft

and valves are inclosed by an aluminum cover and operate in a perfectly lubricated condition.

At the end of the cylinder block there is a vertical shaft which drives the camshaft through bevel gearing. This is called the upper vertical shaft and has a disconnecting joint above the level of the crankcase so that it forms a unit with the cylinder assembly. Thus cylinders, valves, camshaft and camshaft drive form a complete unit which is both light and compact.

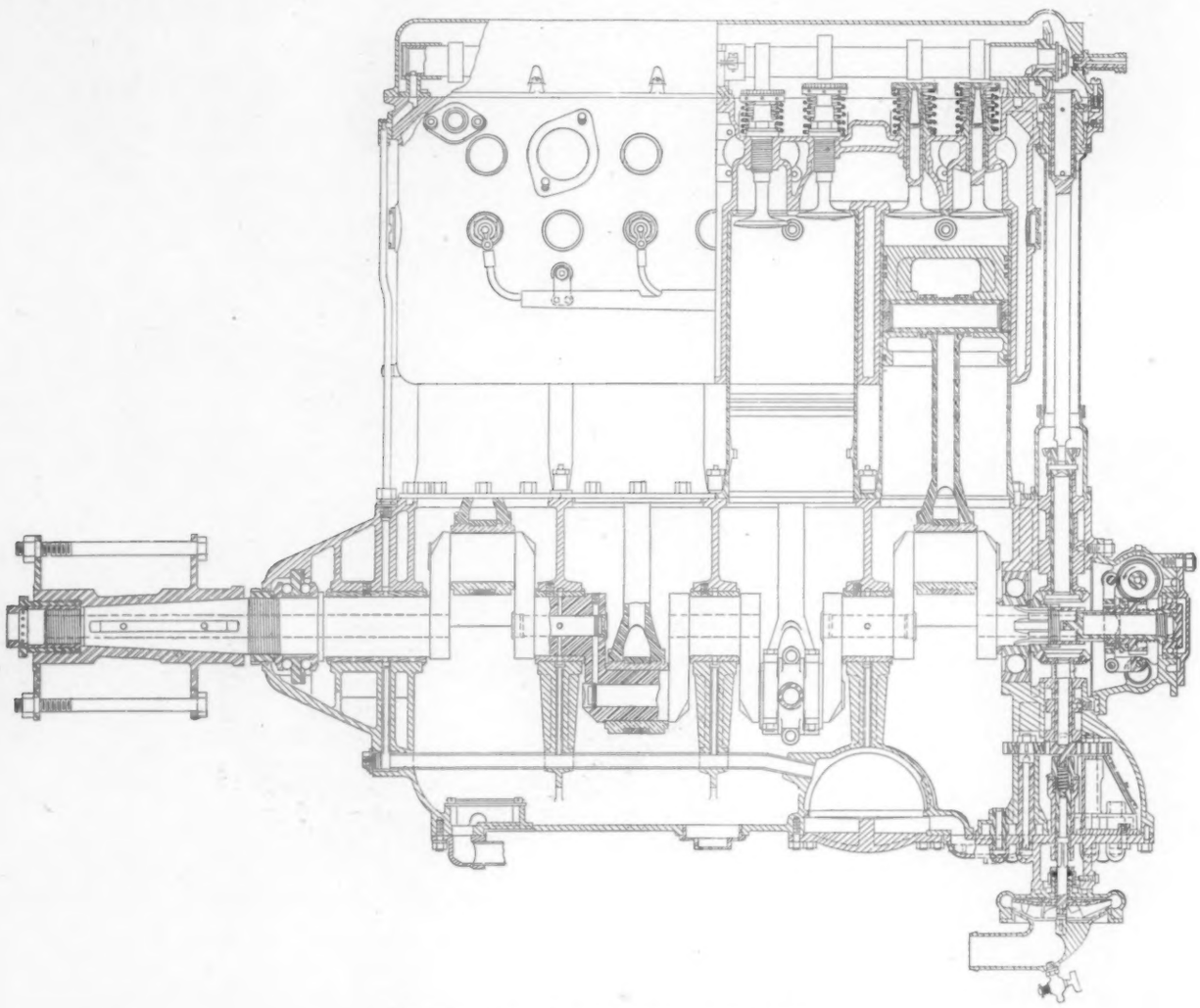
Crankcase

Owing to the nature of the cylinder assemblies the crankcase is comparatively simple. There are upper and lower halves, split on the center line of the crankshaft, and the respective halves of the bearings are carried directly in the crankcase halves. The upper and lower crankcase halves are bolted together very strongly and, since each half takes its share in supporting the crankshaft, the case as a whole is very rigid and light in weight.

Both halves are aluminum castings and the upper half has a projecting foot running the entire length of the case on each side forming the bedplate from which the engine is supported.

In the upper half, at the rear end, there are two short shafts in bronze carriers, called the lower vertical shafts. Each of these shafts has a bevel gear at the lower inside end meshing with a bevel gear on the crankshaft. The upper ends of these two shafts project above the crankcase and are slotted to receive the tongues on the ends of the upper vertical shafts which are attached to the cylinder blocks as described. It is thus possible to remove and replace cylinders without disturbing any of the camshaft drive gearing.

The lower half of the crankcase supports another shaft with a bevel pinion at its upper end, this pinion meshing with the same gear on the crankshaft which drives the camshafts. This shaft is vertical and mounted in a bronze carrier socketing into a hole in the aluminum of the case. The lower end of this shaft carries a small spur gear, by which the oil pumps are driven, and beneath this spur gear is a tongue which provides the drive for the water pump in a manner which will be described later. Thus one bevel gear on the crankshaft drives the two camshafts, the oil pumps and the water pump. This completes all the gearing on the engine except the magneto drive. It should be noted that the vertical shafts between the camshaft and the camshafts run at one and a fifth times crankshaft speed. This fact is of value in obtaining accurate timing.



DIAGRAMMATIC CROSS-SECTION, SIDE VIEW

Crankshaft

The crankshaft is hollow throughout for lightness and for the passage of oil. It is supported on four babbitt faced bronze bearings and one ball bearing, the latter being at the rear end immediately behind the bevel gear. The front end of the crankshaft has a taper on which the propeller hub is mounted and directly back of this is a ball thrust bearing housed in the crankcase.

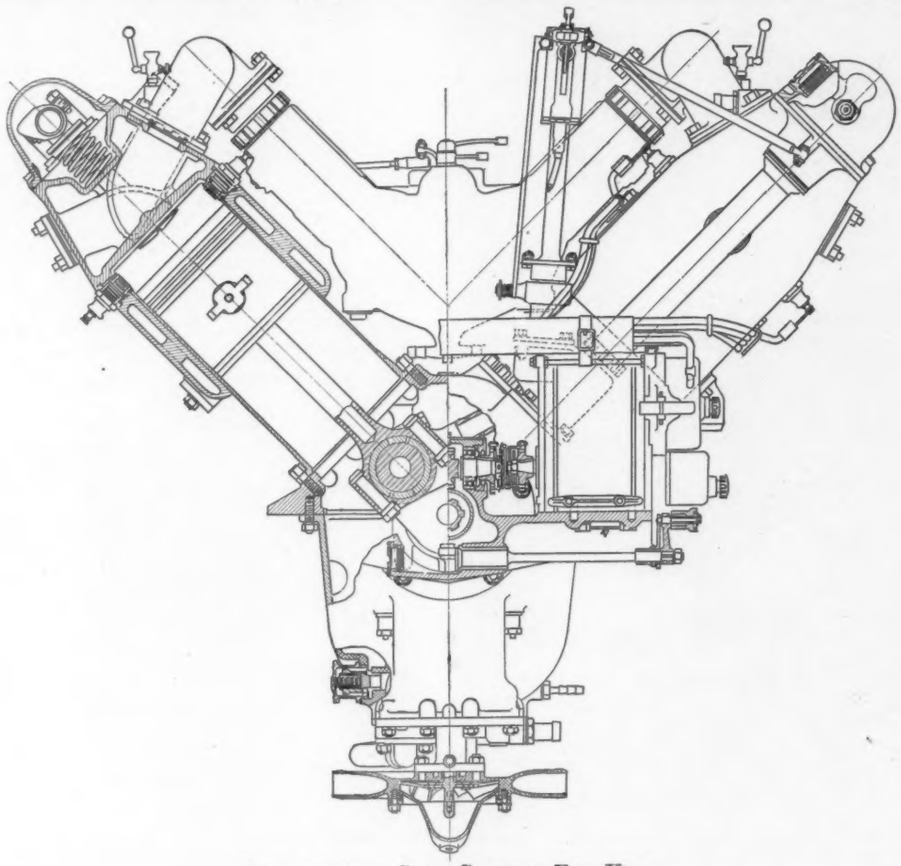
At the rear end of the crankshaft there is a screwdriver slot which is used to drive the magnetos.

Ignition System

Two magnetos are used, firing two sets of plugs simultaneously. These two magnetos are mounted crosswise of the engine on a special bracket bolted to the rear end of the crank-

case, and this bracket incloses a spiral gear. The upper member of this gear has a short transverse shaft on each end of which the magneto couplings are mounted, and this runs in ball bearings housed in the aluminum of the bracket. The couplings float, that is they allow for sufficient universal motion. The lower of the pair of spiral gears has a shaft of which one end is set in a ball bearing in the bracket while the other end has a tongue which engages with the slot in the end of the crankshaft.

This design enables the magnetos to be detached readily, since they are driven by couplings of an easily detachable nature. It should also be noticed that one magneto is arranged for right hand and the other for left hand rotation, as they face apart, but are driven by one shaft.



Diagrammatic Cross-Section, End View

Pistons

The pistons are aluminum alloy of very simple design with a head ½ in. thick, the side walls tapering from this thickness down to $\frac{3}{16}$ in. The purpose of a very thick head is to carry away heat as rapidly as possible from the center of the piston and to distribute it to the walls, whence it is carried off through the cylinders. There are three piston rings placed close together and one oil scraper ring at the bottom, the piston being relieved below this.

The piston pins float, that is, they are free to turn in the connecting rods or in the pistons. To prevent endwise movement of the pins, there is an aluminum plug which closes the outer end of the hole in each piston boss. This plug has tongues which engage slots cut in the piston and therefore cannot turn. This construction is shown very clearly in the plate.

Connecting Rods

There are two types of connecting rod used in each engine. One is forked and terminates in two flat feet, while the other is split and provided with a cap. The forked rod has attached in its feet a split bronze box lined with babbitt which bears upon the crankpin. The connecting rod is attached to the bronze box by four bolts, thus making what is usually known as the "marine type" of rod.

The outside of the bronze box between the feet of the forked rod is turned and forms the bearing for the other connecting rod, which is fitted to it in the conventional way. This construction makes it very easy to replace connecting rod bearings since the old bronze box can be removed and a new one substituted very quickly.

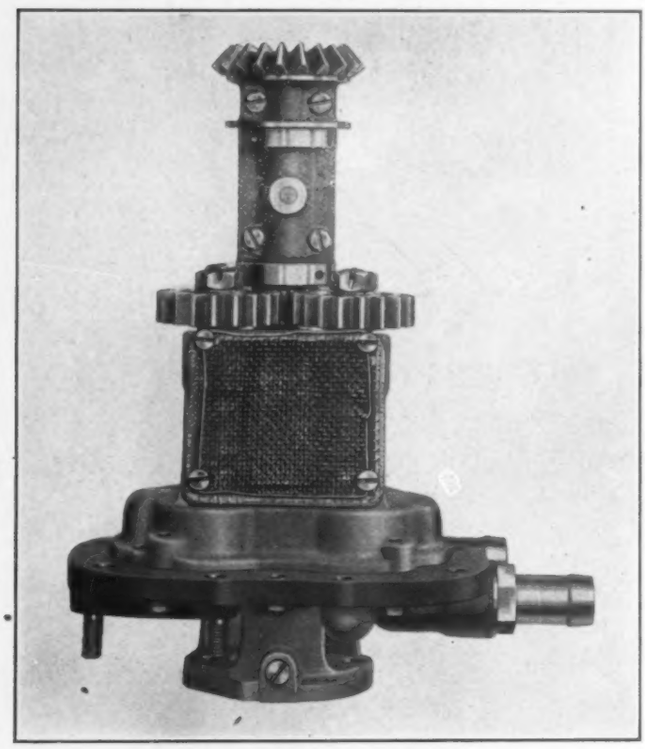
Lubrication System

There is one main oil channel, this being a steel tube cast in the lower half of the crankcase, in which the oil pump is located as already described. From this main channel oil passes to the four main bearings of the crankshaft. Each of the main bearing bushings is completely encircled by a groove cut in the aluminum which is thus kept full of oil. Passing through holes in the bushing oil reaches the crankshaft and passing on through holes in the shaft completely fills the inside thereof, passing out again through other holes which lead to the lower ends of the connecting rods; further holes in the inner connecting rod member lead the oil to the outer rod bearing. Piston and wrist pin lubrication is performed by the oil spray exuding from all bearings.

Camshaft and valve lubrication is obtained by taking oil from the groove around the front end main bearing and leading it up through two small steel pipes, one attached to each cylinder block. These lead to holes in the aluminum, registering with holes in the front end camshaft bearings. Thence the oil enters the camshaft itself, which is hollow from end to end, and small holes drilled in each cam allow lubricant to be discharged directly upon the tappets. These holes are on the opening face of the cam and so oil the tappet head just as the cam begins to lift. The excess not only lubricates the valves themselves but flows into the bearing supporting the upper vertical shaft. Here it obtains access to the space inside the tube inclosing the vertical shaft, falls down this, lubricates the lower vertical shaft bearings and returns to the crankcase through the hole drilled right through the lower vertical shaft. Every bearing and gear is thus taken care of in proportion to its requirements.

There are three oil pumps, which are made up into a unit attached to the lower half of the crankcase. All three pumps are gear pumps, one being a force pump and the other two suction pumps. The force pump takes its supply from an oil tank mounted on the plane and delivers the oil through a large screen, from whence it reaches the main oil channel already described.

Excess oil after completing its circuit is immediately removed from the crankcase by either or both of the suction pumps. One of these is connected to the front end of the case and the other to the rear end so that whatever the angle at which the motor may be inclined, oil will always be removed. The two suction pumps deliver into a common channel which



Oil Pump Unit

is connected to the oil tank, an oil radiator usually being placed between the outlet from the pumps and the tank.

The casting which forms the oil pump body carries four shafts, all vertical. Three of these are for the three oil pumps and on their upper ends are spur gears so arranged that when the pump body is placed into the crankcase, these three gears each mesh with the spur gear on the pump drive shaft described before, this not being disturbed by the removal of the oil pump assembly.

The oil pump body also carries a short shaft arranged centrally and provided with a slot in the upper end which engages with the tongue on the oil pump drive shaft. This provides the drive for the water pump which is attached immediately beneath the oil pumps and may be removed without disturbing the latter.

The oil strainer can also be removed without disturbing the oil pump and is large enough to insure the free passage of oil under all conditions. Each engine has an oil pressure relief valve which can be found on the left hand side of the lower half of crankcase near the center of the engine.

Water System

The water pump is a simple centrifugal type with two outlets. It is placed directly beneath the oil pump, attaching to the crankcase through the medium of a bronze bracket. The lower end of the center shaft in the oil pump is furnished with a square hole, into which the squared end of the water pump shaft fits. The pump delivers through two pipes, to the lower, outside rear corners of the cylinder blocks. From these it passes out to the radiator through two pipes attached to the upper, inside front and corners of the jackets.

Gasoline System

In most airplane installations gasoline is fed to the carburetor by air pressure. For this purpose either valve cover has a box which may be used to carry a small air pump which comprises a bronze cylinder and a piston with a cup leather. The piston is driven from the rearmost exhaustion, its suction stroke being given by a spring that is compressed on the working stroke of the pump. The pump is not adjustable and supplies air at a higher degree of compression than is ever likely to be required. Various regulating devices for controlling the pressure in the fuel tank are in use but these are not part of the engine.

Engine Speed Indicator

The rear end of each valve cover is provided with a threaded boss, and each camshaft has a screwdriver slot in the rear end. In all installations a tachometer or engine speed indicator is used and the flexible shaft for driving this instrument is attached to a special connection supplied with the motor. This consists of a short brass body, screwing in a boss on the valve cover and containing a short shaft meshing with the camshaft slot and arranged at the outer end to take the standard form of flexible shaft connection.

Normally no accessory is driven from the other camshaft and the hole in the end of the valve cover is plugged, but it is always available for driving another accessory.

Airscrew Hub

The airscrew hub which fits on the taper at the front end of the crankshaft is not an interchangeable part in the ordinary sense of the word. Each hub is lapped by hand till it is a perfect fit on the taper and the key only performs part of the function of taking the drive since the hub is drawn very tightly on the shaft. If the hub is not a perfect fit too much stress comes on the key and the hub is liable to "work" on the shaft. This will tear the shaft and hub, and perhaps make it impossible ever to remove the hub.

For locking the hub in place there are two nuts. The inner screws on the crankshaft and the outer into the end of the hub. The outer end fits over the inner so that the two can be rotated together or separately as desired. Owing to the threads being of different pitches, the two nuts when screwed on force the hub on the crankshaft very tightly.

Carburation

The carburetor is a Stromberg, specially designed for this engine.

Performances

Although of comparatively recent design, the Model H has already accomplished some remarkable performances; among these is the world's altitude record of 28,900 ft., established on Sept. 18, 1918, by Capt. R. G. Schroeder, U. S. A., with a Bristol biplane, and the notable performances made by the Loening monoplane, which developed a speed of 145 m.p.h. with full military two-seater load, and climbed 25,000 ft.

Aeronautical Patents

ISSUED NOV. 12, 1918

1,280,906—To Henry Kleckler, Buffalo, N. Y., assignor to Curtiss Aeroplane and Motor Corporation. Hydro landing-base for aircraft.
1,284,907—To Henry Kleckler, Buffalo, N. Y., assignor to Curtiss Aeroplane and Motor Corporation. Landing-gear for aircraft.
1,284,373—Platon Lazarides, New York, N. Y. Airplane.
1,284,590—Gianni Caproni, Milan, Italy. Flying machine.
1,284,825—George R. Van Auken, Minneapolis, Minn. Wing-operating mechanism.
1,284,851—John Ashworth, Toronto, Ontario, Can. Airplane.
1,284,919—John W. Miller, Seattle, Wash., assignor to Boeing Airplane Company. Joint-fitting for truss structures.

ISSUED DECEMBER 3, 1918.

1,286,847—To Joseph J. Walk, Oakland, Cal.—Aerial Machine.
1,286,860—To Frank White, Summitville, N. Y.—Stabilizer for Flying-Machines.

ISSUED DECEMBER 10, 1918.

1,287,182—To Lester S. Barr, Washington, D. C.—Airplane.
1,287,249—To Glenn H. Curtiss, Buffalo, N. Y., assignor to Curtiss Aeroplane & Motor Corp.—Tilting-Wing Flying Boat.
1,287,284—To John R. Gammeter, Akron, Ohio, assignor to the B. F. Goodrich Co., New York, N. Y.—Guide-Pin Structure for Balloons.
1,287,285—To John R. Gammeter, Akron, Ohio, assignor to the B. F. Goodrich Co., New York, N. Y.—Stuffing Box for Balloon Cords.
1,287,076—To Samuel Moses, Jerseyville, Ill.—Flying-Machines.
1,287,083—To Emil V. Noser, St. Louis, Mo.—Aeroplane.
1,287,158—To Emmit Wick, Laura, Ohio.—Flying-Machine.
1,287,134—To Carl R. Swanson, Marshall, Minn.—Parachute.
1,287,297—To Charles Ward Hall, Larchmont, N. Y.—Aeroplane.

The Airship for Commercial Purposes*

By E. M. Maitland, Wing Captain, R. N.

In attempting to form an opinion of the capabilities of airships and airplanes respectively as commercial vehicles, it is important to bear in mind certain phases of past history.

In the first place, the design and construction of airships has up to the present in all countries been mainly confined to the Services, and where private firms have been concerned they have been engaged on producing airships suitable for military purposes. In taking airship performances during the war as a standard of future commercial development it should, therefore, be remembered how vastly different are the requirements of commercial and passenger-carrying airships to those which have hitherto been paramount in the minds of constructors. The modern Zeppelin, for instance, is designed for rapidity of climb, the attainment of great heights, and the carrying of large quantities of bombs, speed being a secondary consideration.

In a commercial airship increased speed will be necessary if a regular service is to be maintained, while a height of 1,000 ft. will be ample for normal flying, though greater heights should be attainable if necessary. The weight-lifting feature would be retained for the carrying of goods and passengers.

Existing German military airships have proved themselves capable of attaining a maximum speed of over 60 m.p.h., with a disposable lift available for crew, fuel, bombs, etc., of over 30 tons, remaining in the air for something like 36 hours, and attaining a height when over this country of 18,000 or 19,000 ft.

There is little doubt that a commercial rigid airship could be constructed today with a maximum speed of 75-80 m.p.h., capable of covering 2,000 miles with a load of cargo of 12-15 tons; or 600 miles with 30 tons of cargo (or 210 passengers with 50 lb. of baggage each).

With care in designing it should be possible to design an airship having the speed named with comparatively slight increase in engine power and of the same size as the present-day Zeppelins. The Germans, owing to the necessity for rapid output, have adopted a comparatively inefficient form from the aerodynamic point of view, but with an airship of true stream-line form the higher speeds should be easily attainable.

The fact that a number of Zeppelins have been brought down over this country and in France does not affect the value of airships for commercial purposes, as the inflammability of the gas with which they are filled does not give rise to any danger in normal flying.† In spite of the enormous amount of flying which has been carried out by airships in this country during the war, there has been no case of the destruction of one of these craft owing to its catching fire in the air.

One of the objections to airships which is frequently raised is their inability to fly in strong winds. This is in part due to the comparatively slow speeds which have been obtained up to the present, for the reasons stated above, and which can undoubtedly be improved upon with careful attention to design having that end in view. It is, however, largely due to the difficulty of handling airships on the ground in high winds owing to the large surface they offer to the wind. There is no doubt that this difficulty would be, to a considerable extent, overcome by the adoption of revolving sheds on land, or floating sheds on water. The best method, however, undoubtedly, would be to abolish sheds altogether—except for docking purposes—and maintain the airships permanently moored out.

The many practical advantages which the airship possesses for commercial purposes are not, perhaps, always appreciated.

Present-day airships, which in no way approach the limit of size, as has already been pointed out, have a disposable lift of over 30 tons, which enables them to embark on long flights without the necessity of descending for replenishment of fuel.

The initial weight of the power plant is, for the same reason, of less consequence than in the case of the airplane, which renders efficient silencing possible, and at the same time simplifies design owing to the weights not having to be cut down to so fine a point. There is no reason why an airship should not be fitted with engines as silent as those of a motor-car. Sleeping accommodation can, in any case, be provided well away from the power plant, and there is complete absence of such noises as the singing of wires which would detract from the comfort of passengers in an airplane. In this connection it may be pointed out that in this country airships have up to the present—owing to the limitations of output—necessarily been fitted with engines designed for airplanes. The special requirements of an airship engine are too detailed to be gone into here, but great improvements are undoubtedly obtainable by the use of such engines. An airship can remain in the air however low the speed may be, so that the engines can be throttled down when required, thus effecting considerable economy in gasoline consumption; while the fact that the engines need not necessarily be run for long periods of time at full speed has obvious advantages from the design standpoint.

The power plant can be readily split up into as many units as desired—there being no advantage in concentrating the weights—and failure in the power-plant does not involve immediate descent, while running repairs can easily be effected in the air.

Even with landing grounds only ten miles apart an airplane would be compelled to fly at a minimum height of about 3000 ft., whereas an airship can cruise with safety a few hundred feet above the ground, which considerably enhances the pleasure of passengers by affording them an opportunity of enjoying scenery.

The difficulty which an airplane pilot has in judging the attitude of his machine to the horizontal at night, or in fog, mist or cloud, does not obtain in an airship, which always remains on an even keel.

An airship can set out on long flights over the sea, or marshy and wooded country without fearing engine failure. At intermediate stopping places it can come down to within a few hundred feet of the ground and moor to a grapnel (or drogue, if over the sea) to replenish fuel, without actually landing. Similarly, an airship can fly at night with complete safety, navigation being carried out by the ordinary naval instruments and observations of the stars made from a steady platform on the top surface.

In conclusion, the commercial airship of the not-far-distant future will have a disposable lift available for crew, fuel and merchandise, or passengers, or 50 to 60 tons or more. It will have a speed of 90 to 100 m.p.h., with ample accommodation for passengers in the shape of saloon, drawing-room, smoking-room and state-rooms, with a lift giving access to a roof garden on the top, and will be able to remain in the air for a week or more at a time. After a journey it will return to moorings like a water-borne ship, only being housed in a shed for periodic overhaul.

* From the Report of the British Civil Aerial Transport Committee.

† This was written before the successful production of a non-inflammable lifting gas—helium—had been made public.

Airship Progress

In 1914 the average endurance of the German rigid airship at a cruising speed was under one day, and the maximum speed about 50 m.p.h.

In 1918, with the German L70 class of 2,195,000 cu. ft. capacity, the endurance at 45 m.p.h. has risen to 177.5 hours, and the high speed to 77 m.p.h. The British R38 class, a contemporary of the German L70, has a capacity of 2,720,000 cu. ft. and an estimated cruising endurance, at 45 m.p.h., of 211 hours.

In a note on the possibilities of the commercial airship, issued recently by the British Air Ministry, it is predicted that future airships will have a capacity of 10,000,000 cu. ft., a propelling apparatus of 6,000 hp., and a high speed of 85 m.p.h. These ships would be 1,000 ft. in length, 150 ft. in overall height, possess a range of 20,000 miles, and could stay aloft for three weeks without requiring re-filling. The crew would consist of three officers and 26 men, and the freight capacity would be 200 tons.

The cost of a 10,000,000 cu. ft. airship is estimated at between $1,000,000 and $1,500,000.

The Naval Aircraft Factory

On July 27, 1917, Secretary of the Navy Daniels signed the document which authorized the only government owned and operated factory this country has ever possessed, the Naval Aircraft Factory; fourteen days later construction work actually began at the League Island Navy Yard, Philadelphia, on a site selected by Naval Constructor F. G. Coburn, U. S. N., who had been appointed manager of the factory. From the day the first spade struck the level bit of pasture upon which the plant was to be erected the work proceeded with incredible swiftness. On Oct. 16, 1917, the first machinery started in motion; three weeks later the keel for the first flying boat was laid, and in March, 1918, the first service machine produced by the factory made its trial flight.

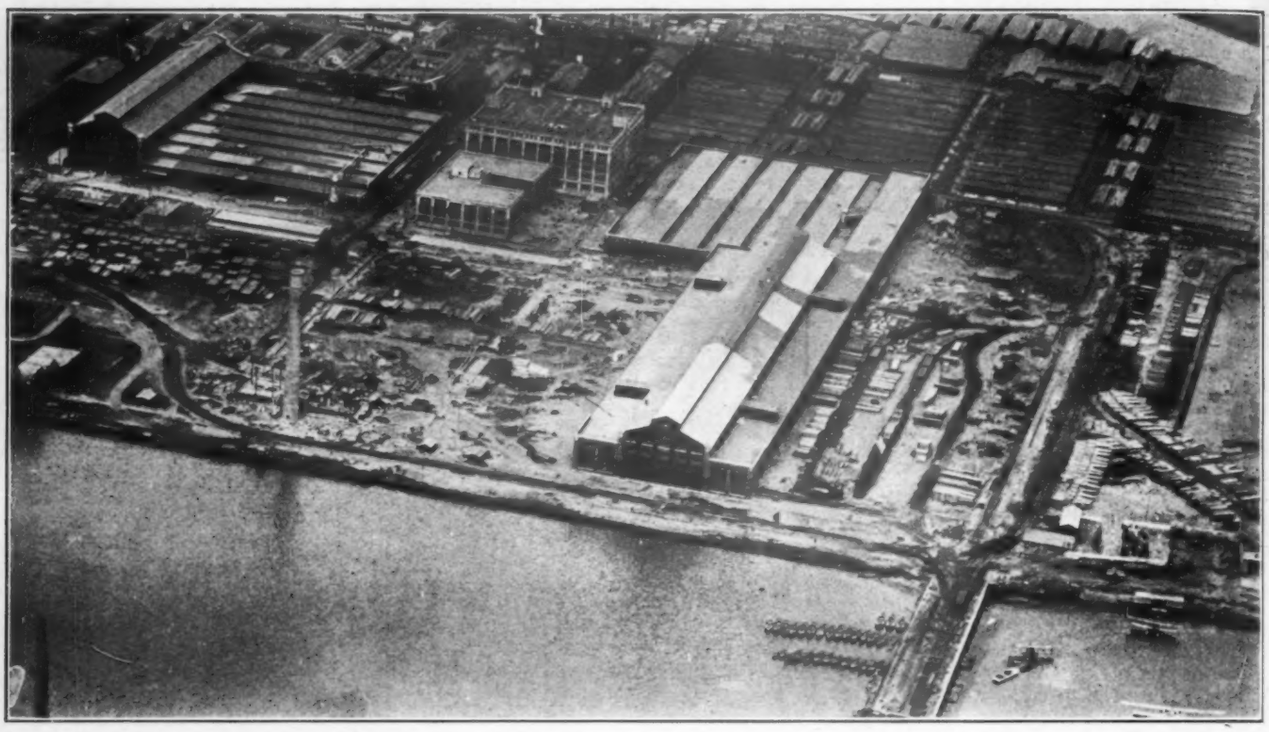


FIG. 1. AIRPLANE VIEW OF THE NAVAL AIRCRAFT FACTORY

FIG. 2. VIEW OF THE FINAL ASSEMBLY PLANT

Site and Dimensions

The original manufacturing unit, with a ground area of 160,000 sq. ft., is a permanent steel structure, which was built and equipped in about three months' time at a cost of about $1,000,000. Early in January the Navy's aircraft program was very largely expanded and this necessitated an enlargement of the Factory, comprising five buildings with a floor area five times that of the original plant. As the augmented program required aircraft at a faster rate than they could be provided by building an entirely balanced factory, the authorization provided that the new extension should be an assembly plant, where hulls, wings, and other parts, placed under contract with private manufacturers, would be erected. The new plant was designed with generous dimensions so as to allow for future increase in size of aircraft, and was laid out for manufacture on most up-to-date lines, presenting particularly the feature of progressive assembly.

The buildings of the Naval Aircraft Factory now extend over 40 acres of ground along the Delaware; the huge assembly plant, which may be seen in Fig. 1, at the right hand side, alone has a frontage of 1,100 ft. The manufacturing plant (visible at the extreme left in Fig. 1) comprises a large woodworking division, a complete metal shop and a boatbuilding plant.

On the day the armistice was signed the factory employed 3,600 workers, fully one-quarter of these being women, while over 6,000 men and women were employed on work contracted for by privately owned firms. The production was at that date one twin-engine flying boat per week, but provision was made for virtually doubling this output, should the need arise.

Internal Organization

The putting in operation of this huge plant in record time constitutes an achievement which is to the highest credit of Navy methods as well as to the executive ability of Naval Constructor Coburn, manager of the factory; this is strikingly illustrated by the fact that of the 3,600 workers employed only twenty-five have had previous experience in aircraft work.

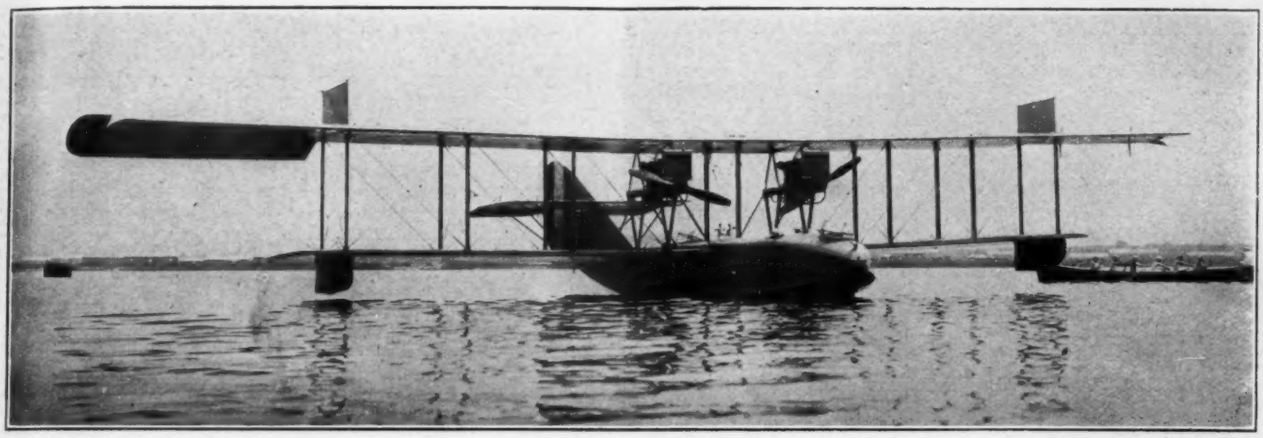


FIG. 3. THE NAVAL FLYING BOAT F-5-L

At the time the factory began operations, experienced aircraft workers had all found a berth in the industry, while regular Navy officers capable of acting in executive position in connection with aircraft work were few in numbers, and generally engaged on other duties. The need for an executive force and a technical staff was filled by selecting from civil life men particularly adapted to the needs of such an undertaking, and it is interesting to note in this connection that no two of the principal department heads came from the same line of industry. The problem of supplying man-power fell upon

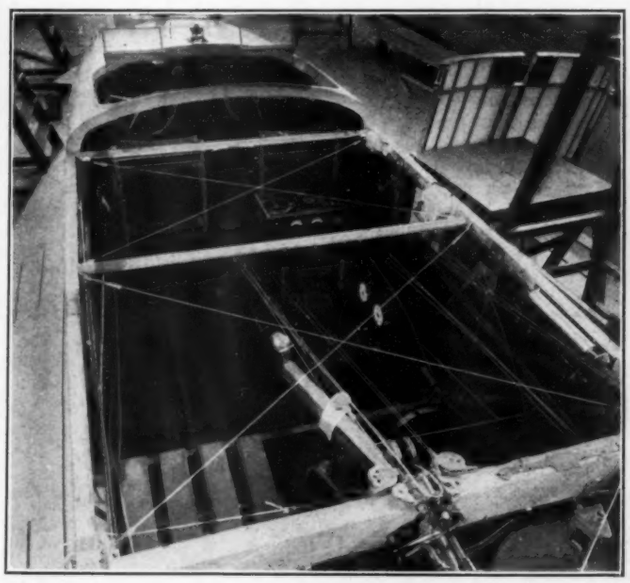


FIG. 4. INTERIOR OF THE PILOT AND RADIO COMPARTMENTS OF AN F-5-L

the Employment Division; this used all usual methods, including those provided by the Government, and did not stop at recruiting talent, but also developed it. For this purpose an apprentice school was organized, in which women with no previous training, and actuated only by patriotism, were instructed in factory rules and methods. This method has given most satisfactory results.

The Engineering Department covers the designing of experimental and production machines, and the inspection and testing of material, work in progress and the completed product; it also includes a Trials Section, for the testing of finished seaplanes under the direction of skilled pilots. This department also draws up specifications for materials, and issues instructions for working and applying them in aircraft construction.

The Manufacturing Office receives the requirements of the Navy Department and accumulates all necessary data for the requisition of materials, issuance of orders to all factory departments and the scheduling of work and equipment.

The Supply Department insures the rapid transportation of the finished aircraft to their destination.

The Contract Manufacturing Department is responsible for maintaining the output of the assembly plant at its highest capacity by supplying the component parts of the finished product for final assembly. For the manufacture of hulls the yards of many former yacht builders were utilized; for wing panels several large woodworking establishments; for metal parts and fittings various industries were called upon, among others a grammophone plant. At all of these places branch offices were created for the directing of production, for inspection, and for technical instruction, by the agency of a technical personnel supplied by the Naval Aircraft Factory.

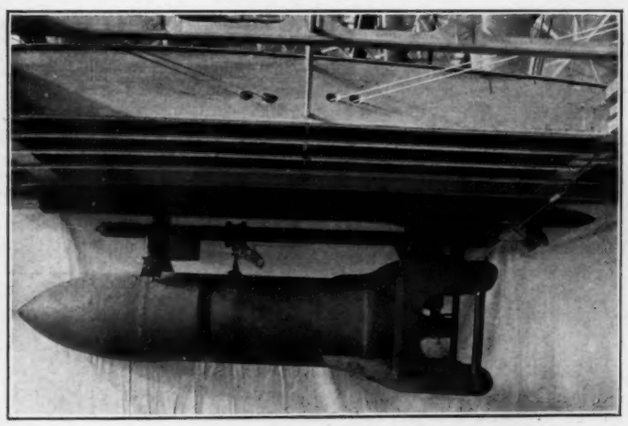


FIG. 5. A BOMB IN ITS CARRIER ON AN F-5-L

The spirit which permeates the whole establishment, from the executive force down to the smallest shop hand, was aptly expressed by the Manager's own words in an address delivered to the organization: "Let us make our product so well and so fast that the only reason the public will have for investigating us is to find out how in the h——l we do it." And it is indeed a matter of record that while the progress of the Army aircraft program was punctuated by a remarkable series of errors and failures, which involved the wastage of huge sums, the work of the Naval Aircraft Factory has proceeded throughout the war with a silent efficiency that thoroughly fulfilled the expectations placed upon it.

The Naval Flying Boats

As its name indicates, the Naval Aircraft Factory was originally destined to fill all the aeronautic needs of the Navy, which means that it was eventually to produce lighter-than-air as well as heavier-than-air craft. However, under the stress of war it was considered most expedient not to undertake for the time being the construction of lighter-than-air craft, which has until quite recently been a subject of considerable novelty

FIG. 6. THE N-1 SEAPLANE

in this country. Therefore, excepting the construction of a few airship cars, the work of the Naval Aircraft Factory has during the war entirely centered upon producing a type of seaplane which was urgently needed in large numbers to overcome the increasing menace of the submarine, by convoying ships through dangerous zones, patroling the shore lines and attacking underseas craft with depth bombs.

The so-called large patrol craft developed for this purpose, the F-5-L seaplane, is a flying boat of 107 ft. span, 50 ft. length and 8 ft. chord, which is fitted with two low-compression Liberty-12 engines of 400 hp. each, driving tractor screws of 10½ ft. diameter. Fully loaded, with one Davis and four Lewis guns, the necessary ammunition, four 230 lb. or two 500 lb. bombs, radio apparatus, a telephone system of six stations, carrier pigeons, 500 gal. of gasoline, and a crew of five, the machine weighs 14,000 lb. Its fuel supply endows it with an endurance of 10 hr. at a maximum speed, near the sea level, of 102 m.p.h. Its ceiling is in the neighborhood of 14,000 ft.

Constructionally, the machine follows the best modern practice of seaplane design. The hull is built up of ash longitudinals and formers, to which is riveted a double planking of cedar, Spanish on the outside, Port Orford on the inside. Aft of the engines steel tubing is used for the cross pieces of the hull. Generally speaking, the boat has a V-type bottom which extends laterally beyond the sides of the hull so as to form two acute-angle fins; these materially assist the boat in taking off, and incidentally endow it with a greater stability when resting on the sea. There are two gun cockpits, one forward and one aft of the wings; behind the forward gun cockpit is fittted a spacious pilot compartment, seating two men side by side. Behind the latter, and under deck, is situated the radio installation, to which access is had through a manhole. The wing and tail units are built up of ash and spruce members of orthodox design.

FIG. 7. SECRETARY DANIELS IN CONVERSATION WITH NAVAL CONSTRUCTOR COBURN

Six thousand distinct pieces of wood go into the making of this machine, and to hold these in place requires 50,000 wood screws and 46,000 nails, braces and tacks. In the hull 600 sq. ft. of veneer and 4500 sq. ft. of cotton fabric are used. The 250 pieces of tubing aggregate 1000 ft. in length and to adjust the tension on the 5000 ft. of wire and cable, 500 turnbuckles are required; about 1500 each of bolts, nuts and washers are needed to hold in place the 1000 metal fittings. Nothing could give a better illustration of the great size of this machine than the fact that on a recently developed model, the F-6-L, which shows several improvements over its forerunner, a matter of 600 lb. has been saved in the dead weight of the hull owing to constructional refinements.

Besides these large patrol craft, which have constituted the production job of the Naval Aircraft Factory, various types of seaplanes, destined for special duties, have been built for experimental purposes. One of these is the N-1 pusher seaplane, which was designed by Naval Constructor J. C. Hunsaker, U. S. N., to permit the mounting of large caliber guns of the Davis type for use against submarines (Fig. 6). This machine has not, however, been further developed because the F-5-L type flying boats proved to have sufficient stability for mounting beside other offensive armament one of these guns.

The Miller 125 Hp. Aircraft Engine

This engine, which is manufactured by the Harry A. Miller Mfg. Co., of Los Angeles, Cal., is of the vertical type, with four cylinders in line. The cylinders have a bore of 4 in. and a stroke of 7 in., giving 352 cu. ft. piston displacement. Although the engine has a normal rating of 125 hp., its power output can be raised to 139 hp. at 2600 r.p.m., and 155 hp. at 2900 r.p.m. As it is not desirable, for reasons of safety and efficiency, to run an airscrew at such high rotational speeds, the Miller engine is fitted with a reduction gear, which has a ratio of 1 to 1.85, whereby the speed of the airscrew is reduced to from 1350 to 1400 r.p.m. The airscrew designed for this engine has a diameter of 8 ft. 4½ in. and a pitch of 6 ft. 1 in.

A noteworthy feature of this engine is that all its parts are interchangeable.

Water Jackets and Crankcase

The water jackets and the crankcase—of the barrel type—are cast integral of *alloyanum*, a special alloy developed by the firm. Pistons and connecting rods may be easily removed for inspection through side plates, without removing the engine from its bed.

Cylinder Heads

The cylinder heads are cast alloyanum. Four cast iron valve seats for each cylinder are cast integral with the head. The head is held on by 14 studs.

Cylinders

The cylinders are sleeves cast of vanadium iron, completely machined. The sleeves are easily inserted in the water jackets, and are packed with rubber ring gaskets. The cylinder head rests on the cylinder sleeves and holds them in place.

Crankshaft

The crankshaft is counterbalanced and constructed of two parts, put together in the center with taper, key and nut, and carries three annular double row ball bearings.

Connecting Rods

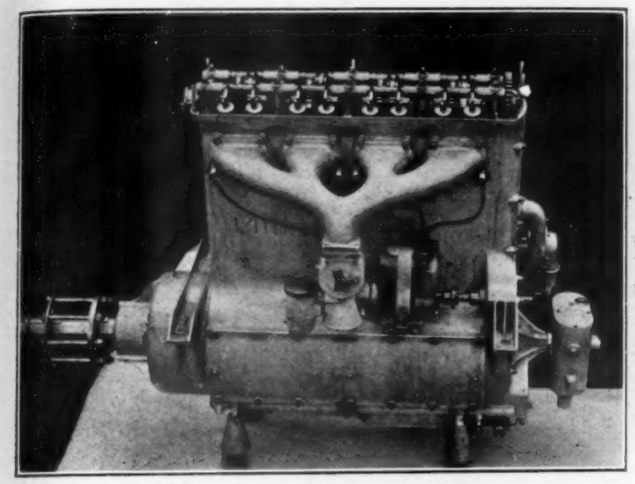
The connecting rods are tubular and slightly tapered. Bearing cap is held on by four bolts. The bearings are bronze, lined with white metal. Wrist pins are clamped in rod.

Valve Gear

The cam shaft is built up of four cam units, and five annular ball bearings, mounted on a tubular shaft. A cam unit

comprises an inlet cam and its follower, and an exhaust cam and its follower. The follower cam causes the rocker to follow the main cam, giving a positive movement to the rocker. The cam shaft is incased and runs in a bath of oil.

The valves are of tungsten steel, and operate in cast iron bushings. Two springs per valve are used.



INDUCTION SIDE

Timing Gears

The cam shaft, magnetos and water pump are driven by a train of spur gears, mounted on double row annular ball bearings.

Pistons

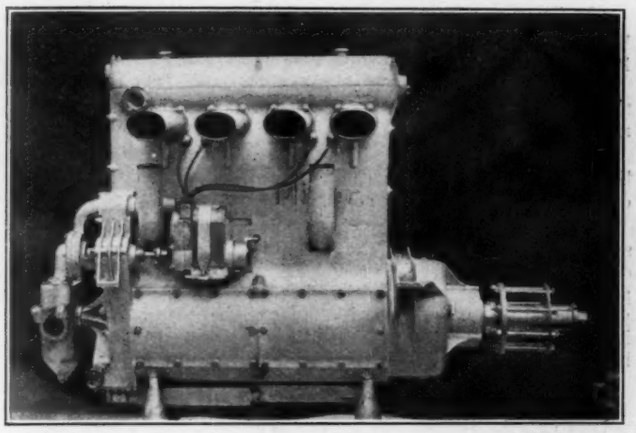
Pistons are made of a special alloyanum, and are fitted with two concentric rings. Wrist pin bearings are in the piston.

Lubrication System

The oiling is a dry base system. The gear oil pump is constructed in three sections. One section draws oil from the supply tank and forces it to all parts of the engine under pressure. The other sections draw the oil from each end of the case and deliver it to the supply tank. All oil passages are cast integral with the engine. Connecting rods are oiled with collector rings. All oil passes through a series of screens.

Reduction Gear

The reduction gear is of the planetary type. The three reducing gears are mounted in a case concentric with the propeller shaft. The airscrew shaft is on a center line with the crankshaft. All are mounted on double row annular ball bearings..



EXHAUST SIDE

Ignition System

A complete and separate magneto ignition system is placed on each side of the engine.

Water Pump

A centrifugal water pump is placed at the front end of the engine.

General Dimension

Height, over-all	34	in.
Width, over-all	18¼	in.
Width between engine bolt arms	16¼	in.
Length between engine bolt arms	27¾	in.
Length from end of oil pump to end of gear housing	41	in.
Weight complete	410	lb.

Commercial Transport by Airplane*

In considering the possibilities of the employment of aircraft for purposes of the transport of passengers, mails and parcels, the Special Committee directed an inquiry† to be made as to (i.) four existing types of airplane, and (ii.) rigid airships. With regard to airplanes, the following four types were selected, viz.:

(1) The Handley-Page, with 250 hp. Rolls-Royce engines, and the "America" flying boat.

(2) The de Haviland 4, with 250 hp. Rolls-Royce engine or 230 hp. B.H.P. engine.

(3) The R.E. 8, with the R.A.F. 150 hp. air-cooled engine.

(4) The Sopwith "Pup," with an 80 hp. Le Rhone engine.

These types were selected to cover the whole range of well-known machines with a view to estimating the possibilities of transport from existing data.

Col. O'Gorman and Mr. Bairstow presented the following general conclusions to the special Committee on the hypothesis of aerial transport in still air:

(*a*) It is profitable, so far as fuel consumption is concerned, to fly high.

(*b*) It is profitable, so far as fuel consumption is concerned, and so far as the cost of airplane construction is concerned, to use a heavy loading of the wings.

(*c*) Since high-wing loading means fast alighting, the provision of first-class grounds will, it is considered, lead to economy of transport. The sub-committee contemplates landing speeds upwards of 60 m.p.h. This does not refer to seaplanes or flying boats.

(*d*) High speed of flight is in direct conflict with great weight carrying capacity.

(*e*) It follows from *d* that, in selecting the flying speed of the airplane to be used, a compromise must be struck between the value of (1) fuel and labor economy and (2) speed or time-saving.

(*f*) As illustrating *e*, a lightly loaded airplane, such as is commonly used now, cannot possibly at 120 m.p.h. (low level speed) fly 1,000 miles, that is to say, there will be no lift available to carry even the flyer; whereas, at 80 m.p.h., no less than 30 per cent. of the gross weight of the airplane becomes available for crew and commercial load.

(*g*) The comparatively small importance of rapid climbing in commercial air work will make the possibilities of combining high speed and weight-carrying much better than those of the modern service airplane.

(*h*) The cost of production of airplanes (taken over the range of variations of type presented by the four service airplanes selected and based on quotations for large quantities) is roughly proportional to the total crew and useful load carried; and this in turn is equally proportional to the total gross loaded weight of the airplane—viz., at war prices about £900 per every 1,000 lb. of gross weight.

With regard to conclusion (*f*), a comparison is drawn therein not between two performances of one machine, but between performances of two different machines, one designed to fly at 120 m.p.h., and the other at 80 m.p.h.

In making any definite recommendations as to commercial transport by airplane the Special Committee have felt that, for the reasons stated in the beginning of this report, it is impossible at the present stage to fix upon any particular type, and, therefore, they present the following general conclusions from the technical point of view.

* From the Report of the British Civil Aerial Transport Committee (Interim Report of Special Committee No. 2).

† With regard to the types of airplanes selected, it should be noted that this inquiry was directed in July, 1917.

(1) That for commercial success speed is probably the most material factor.

(2) That for commercial success the speed needed depends very greatly on the conditions of competing methods. Between large centres connected by direct high speed railways, ground speeds of 100 m.p.h. are desirable; but for linking places between which the railway service is slow or interrupted by sea crossings, lower speeds will be found commercially practicable.

(3) That, at present, stages of about 500 miles would be the normal limit, but that it will be desirable from the commercial point of view that stages should be as long as possible.

(4) That it is desirable as speedily as possible to develop the existing facilities for night flying, especially for the carriage of mails.

(5) That heavy loading is necessary for commercial success, but, since this will involve a high landing speed, development of land and air brakes is necessary.

(6) That in view of certain disadvantages of high landing speed, efforts should be made to keep loading as low as possible consistently with securing a commercial rate of speed and to provide for aerodromes and landing places possessing the best possible surfaces, and that it may well be hoped that future inventions and improvements in design will enable a lower landing speed to be attained without sacrifice of flying speed.

Prime Cost

It is practically impossible to give any satisfactory estimate of running costs of either type of aircraft from existing data.

General figures relating to cost must be considered as indicative only; the weight of an airplane is not a definitely fixed quantity, and the amount of commercial load depends on the length of journey.

Figures qualified as above are:

	Prime cost per lb. of gross weight	Prime cost per lb. of disposable load	Prime cost per lb. of commercial load
Airplane (high speed).....	18s.	40s.	Upwards of 40s.
Airplane (low speed).....	18s.	30s.	Upwards of 30s
Airship (rigid)	9s.	18s.	Upwards of 18s.

Air Routes Generally

In considering the planning and definition of particular air routes, certain general considerations arise. In the case of a commercial aerial service the route will generally begin or end at some large town or centre of population; but its course may vary in accordance with the needs of intermediate towns in a populated country and in accordance with the factors of prevailing winds and landing facilities in the case either of long journeys over undeveloped countries or of long journeys over the sea.

In the two latter instances the necessity for a planned and defined route is sufficiently obvious, for in the case of a flight over, *e.g.*, Africa, the provision of landing facilities on a liberal scale is impracticable, and in the case of a flight from America to Europe prevailing winds will play a large part in fixing outward and homeward tracks. In the United Kingdom, or at any rate in England, present and future military requirements will involve the creation of a large number of landing grounds, but where mails have to be delivered the provision of definitely marked routes is necessary for the sake of economy, speed, reliability and safety of navigation.

The Atlantic Route

As to the Atlantic route, Commander Porte pointed out in his report that for some time to come a direct route from Ireland to Newfoundland and *vice versa* will be found impracticable. He suggested that the only possible solution of the Trans-Atlantic route at the present time, and for many years to come, would be to use the so-called "Azores" route, employing San Miguel, the principal island of the Azores, as a landing station. To avoid the great distance of a direct flight from the United Kingdom to San Miguel, he recommended a route from London via Paris, Madrid and Lisbon, the distance from Lisbon to San Miguel being 775 miles. From San Miguel to Newfoundland is 1,346 miles, although this distance could be reduced to 1,045 miles by calling at Flores, another of the Azores group. The use of Newfoundland as a terminus presents great difficulty owing to continual fog on the banks and around Newfoundland itself. The effect of this fog is to make a journey westward to Newfoundland liable to the danger and uncertainty involved in having to come down to land through the fog. The same difficulty does not occur in the eastward journey from Newfoundland, in that the pilot can lay his course by the compass and would within a comparatively short period find himself outside the fog area.

Commander Porte's conclusion is that, at any rate in the immediate future, it would be preferable to fix upon New York as the Western terminus of the Atlantic route. The distance from San Miguel to Long Island is roughly 2,250 nautical miles, and Commander Porte suggests that for the purpose of dividing this long distance into reasonable stages it would be necessary to design and arrange for "Sea Stations," in the shape of long ships of, say, 600 ft., with a clear upper deck of 400 ft., fitted with wireless and the necessary signaling apparatus. Such an arrangement would make possible the use of airplanes rather than seaplanes.

While Commander Porte is a high authority, the Special Committee do not feel that they possess sufficient independent information to enable them to express a confident opinion with regard to his conclusions. So far as these are based upon the prevalence of fog on the Newfoundland coast, Major Taylor is disposed to think that they are open to question. Major Taylor's impression, based upon his study of the subject, is that the sea fogs prevailing off the Newfoundland coast are low in altitude and do not extend far inland. Any further evidence that could be obtained on this point would be valuable.

Here, again, the Committee can only recommend that a practical experiment should be instituted as early as may be possible, all available information as to the weather conditions likely to be encountered that may be in the possession of the Meteorological Office or of the Governments of the U. S. A., Canada, and Newfoundland having first been studied with a view to undertaking the experiment with the best chances of success.

This route would appear to be a particularly suitable one for an experiment with airships as well as with airplanes, the distance in a direct line from the East Coast of Newfoundland to the West Coast of Ireland being no more than could be accomplished in favorable weather by airships already in existence.

Marking of Aerial Routes

As to the marking of aerial routes, several recommendations have been made.

Wing Captain Groves has suggested that all main routes should be marked at intervals of five miles by a strip, 200 ft. in length and 16 ft. in breadth (formed of chalk or small stones treated with some white mixture), each mark pointing exactly along the line of route. He recommends, also, that alongside each mark should be an alphabetical letter, 50 ft. in length, to indicate the routes to which they belong; while, in addition to these letters, each mark should have its distinguishing number, in figures 16 ft. high. In clear weather these figures would not be required by the pilot, but in thick weather, rain, or other adverse conditions, they would help him to discover his exact whereabouts.

Lieutenant-Colonel O'Gorman, after considering the memorandum by Captain Groves, suggested that main railway routes should be identified by various combinations of dots and dashes formed by lines of chalky stones, but the representative of the Board of Trade expressed the view that there would be serious difficulties in the practical working of this proposal.

One suggestion which meets with the approval of the Special Committee, is that the roofs of railway stations or sheds should have their names painted upon them in letters large enough to be distinguished by the pilot of an aircraft. It would be of great advantage that these letters should be brightly illuminated at night.

The Special Committee recognize that while it may meet the case for a military aviator to find his way from one landmark to another, or to follow some convenient railway, even should this take him a little from his course, a commercial pilot, carrying mails, say from London to Paris, will find any deviation from the direct line reflecting itself adversely not only in his time-table, but also in the matter of fuel consumption. It may be thought necessary, therefore, by those who operate such commercial services, to lay down some very clear system of landmarks, so as to ensure an absolute adherence by their pilots to a given line of flight.

The Bijur Airplane Engine Starter

The Bijur airplane engine starter was designed at the request of the Bureau and of the Airplane Engineering Department of the Signal Corps for use particularly on seaplanes. It was desired to obtain a starter of minimum weight and low current consumption combined with a maximum of cranking power to break away a stiff engine. It was thought that the obtaining of these results would necessitate the cutting down of the cranking speed to a very low value, but, as will be seen from the data given below, the desired results have been obtained without undue sacrifice of speed.

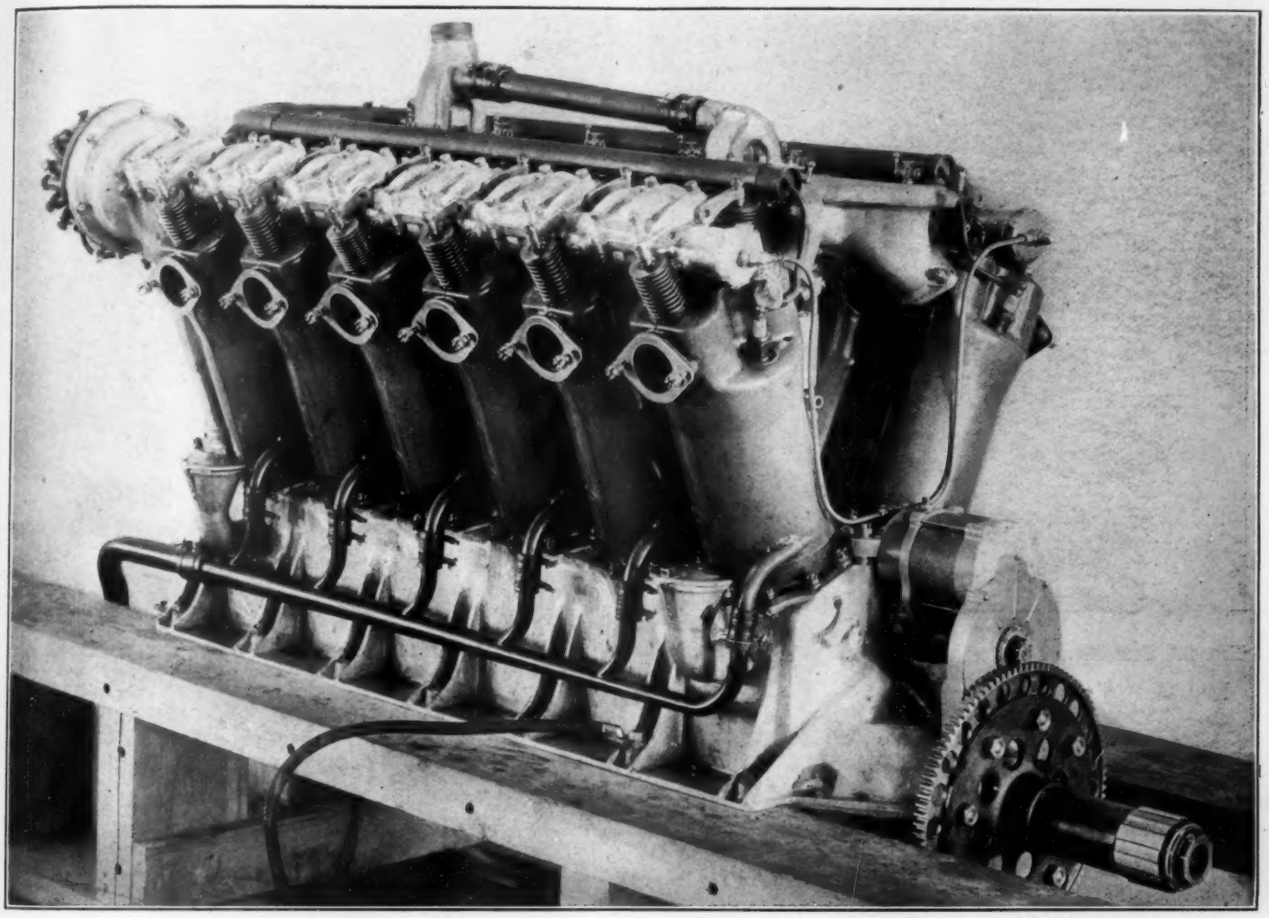


FIG. 1. LIBERTY-12 ENGINE FITTED WITH A BIJUR STARTER

Characteristics

Weight of starting motor, 20.5 lb.
Weight of gear ring, 3.6 lb.
Cranking current, 90 to 150 amp. (depending on condition and stiffness of engine).
Cranking speed (engine), 40 to 50 r.p.m.
Torque available on engine crankshaft to break away a frozen engine, 1300 ft. lb.

As will be noted from the accompanying illustrations, this starter consists of an electric motor, 4 in. in diameter, fitted with a double gear reduction and a special form of the Bijur automatic pinion shifting mechanism. This is similar in nature to the Bijur shift used on automobile starting apparatus, but much refined and lightened for this special use. The motor mounts directly on the propeller end of the Liberty engine without the use of intermediate bracket (Fig. 1).

To mount the starter on the Liberty engine, two nuts at the base of the end cylinders (A, Fig. 2) are removed and replaced by two extension studs supplied with the starter. Two lugs on the starter motor casing fit over these and are retained by the original nuts which are put back on the extension studs (Fig. 3). The two bearing bolts at the extreme propeller end of the engine crankcase (Fig. 2) are removed and replaced by two long studs which project from the bottom of the starting motor housing.

Normally there is no connection between the starting motor and engine crankshaft. A gear ring is placed between the propeller hub flange and the propeller, and is held by the regular propeller hub bolts passing through holes in the gear, jig-drilled for the purpose. The pinion of the starting motor is retained within its housing when at rest. When the starting switch is depressed, it automatically meshes with the teeth of the gear ring and cranks the engine. The starting of the engine under its own power automatically demeshes the pinion. Provision is made which eliminates the possibility of the teeth jamming and they will not mesh if the switch is depressed while the engine is running. The use of an eight-tooth pinion is something of an innovation and makes possible a high gear reduction.

The battery used is a special type made by the Willard Storage Battery Co., and designated as type COR-26. This has 6 cells, rated at 24 ampere hours and weigh approximately 35 lb. One battery is used to supply as many starters as are fitted to the plane. Tests on the three-engined naval flying boat NC-1, at Rockaway, showed that this battery has a capacity to start all engines 50 times each. Lighter batteries are being developed, however, and it is expected that eventually a battery of about 25 lb. weight will be used.

The propeller end of the engine was selected as the most convenient place of application, because it makes possible the use of a very simple and sturdy form of drive from the starting motor to the crankshaft, without the use of clutches or couplings. It also makes use of space not available for other purposes, while it is often desirable to drive small auxiliaries from the ignition end of the engine.

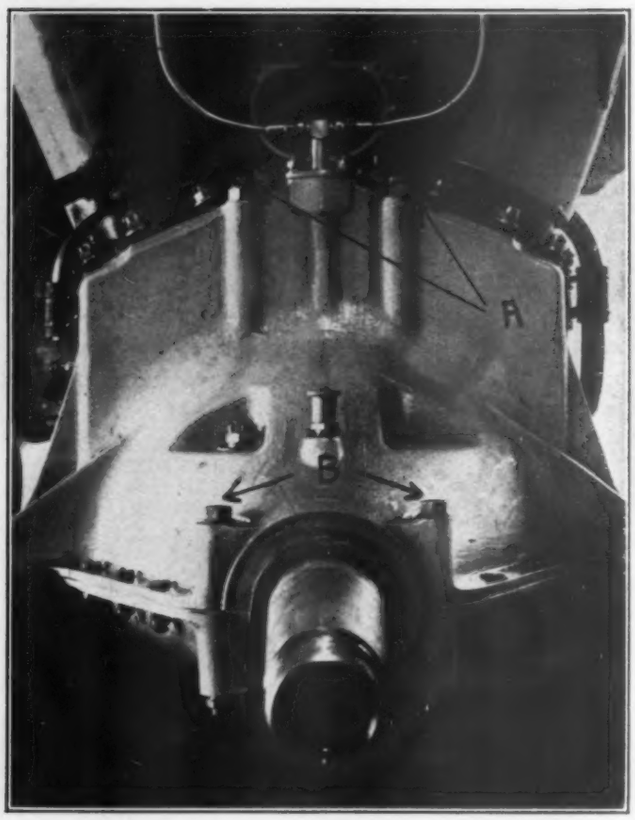


FIG. 2. THE BASE FOR THE STARTER ON A LIBERTY ENGINE

The application to the Hispano-Suiza engine is very similar, the only difference being in the mechanical application to accommodate the offset position of the propeller. For this purpose an aluminum web is furnished by the firm to go between the hub flange and the gear ring. A similar web is furnished for use with the offset propeller position on the Liberty engine.

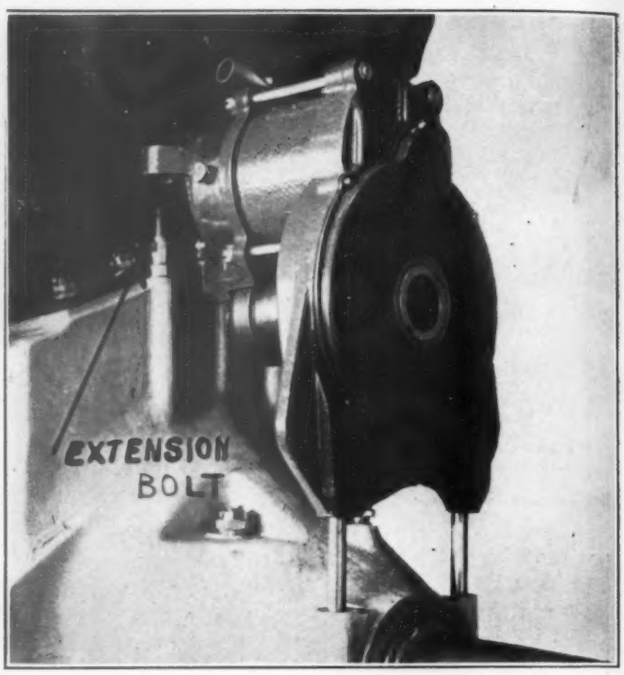


FIG. 3. FITTING THE STARTER TO THE PROPELLER END

Aeromarine Flying Boat, Sportsman Model

The Aeromarine Plane and Motor Co. has just placed on the market a two-seater flying boat, illustrated herewith, which has been specially designed to answer the requirements of the sportsman fond of water flying.

Machines of this type are ready for almost immediate delivery. In addition to this model a larger flying boat is being produced which will have similar characteristics to the machine here described, but will be fitted with seats for two passengers and a pilot.

Hull—The hull is constructed, for the most part, of waterproof plywood, which avoids a number of seams which might leak, and also the great amount of riveting that occurs when narrow planking is riveted to battens.

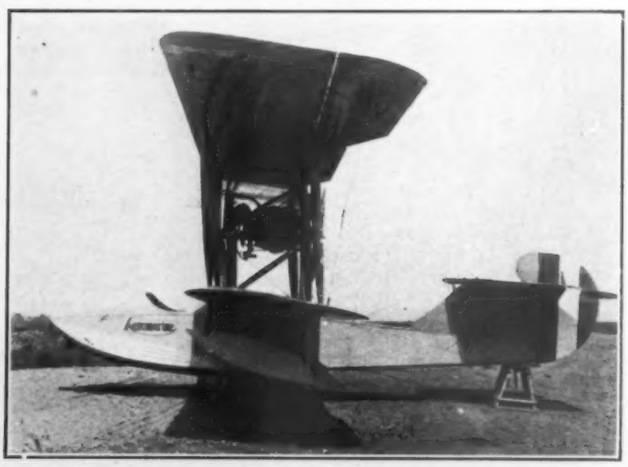
One of the most interesting features of the hull construction is the use of plywood frames. These frames are sawed in one piece from a large sheet of water-proof plywood. This system does away with the difficulties which have always been experienced at the corners of built-up frames, and in addition the new type of frame is lighter and stronger than the old one.

The bottom of the boat is constructed of built-up plywood, riveted with cloth and marine glue between.

Seating Arrangement—The pilot and passenger sit side by side, and the company proposes to supply either the "dep" or stick control.

Wing Structure—The wings, struts, etc., are of exceedingly robust design, and the machine has a factor of safety of 7—8.

The Aeromarine Plane & Motor Company proposes to equip these machines with its six-cylinder, 130 hp. type L engines, which are equipped with electric starters. It will, however, install any engine to suit the customer's wishes.



AEROMARINE FLYING BOAT, SPORTSMAN'S MODEL

General Characteristics

The general characteristics of this machine are as follows:

Spread—upper wing	48 ft. 4 in.
Spread—lower wing	37 ft. 4 in.
Stagger	10 in.
Chord	75 in.
Gap	78 in.
Dihedral	2 deg.
Areas upper panel (with ailerons)	304 sq. ft.
Areas lower panel	200 sq. ft.
Ailerons, each	29 sq. ft.
Elevators	15.25 sq. ft.
Stabilizer	39.5 sq. ft.
Vertical stabilizer fin	15 sq. ft.
Rudder	15 sq. ft.
Skid fin	5.5 sq. ft.
Length over all	25 ft. 6 in.
Weight (light)	1925 lb.
Weight (loaded)	2485 lb.
Gasoline	35 gal.
Wing float buoyancy	264 lb.

Organization of Aerial Ports*

By Gino Bastogi

Aerial ports should not be merely pleasant places affording shelter against storm and bad weather, but their facilities should be up-to-date, and their organization at the same time amply advertised by means of illustrations and, as far as possible, by photographs, in order that every detail may easily be imprinted on the mind of airmen, many of whom will certainly only have to fly a circuit between two, three, or four stations. Many others—and their number will increase in proportion as flying gradually becomes a mere controlling of stabilizing and steering appliances—will fly long distances, and it will be most useful for them, and also better, to *know* the kind and extent of arrangements made at their ultimate destination.

In the first place, aerial ports should indicate arrival and departure places very distinctly, so as to be visible from high altitudes and long distances. The necessity for this will increase with the growing traffic of the stations themselves, so that pilots should not have to make long spirals, which, with a consumption of 3-4 kg. of gasoline a minute, would soon become considerably more expensive than the arrangements made on the ground to avoid them. Secondly, it is obvious that the space reserved for departure must be appreciably wider than that intended for arrivals, and provided for in the center of the ground, in order to allow the departing machines as much space as possible, thus enabling them to attain in due time the necessary speed to fly over the buildings surrounding the station without touching them.

Close to the hangars, stores, post offices, and waiting-room will be the tracks, made of rammed earth and carefully kept in a sufficiently hard condition—for example, with a sprinkling of tar, which will do away with dust and make the ground dark, on which all the traffic for loading, unloading, and supply can easily move. The tracks must, of course, be sufficiently wide for the convenient handling of any kind of machines.

Immediately next to the tracks, toward the centre of the station, will be the starting ground, enabling machines to obtain the speed necessary to leave the ground quickly. The simplest manner in which this can be obtained seems to me to be that the ground should consist of a layer of cement, at least twice as wide as the widest road, and its whole length bordered with strips of rubber level with the ground, indicating—particularly on the sides of the tracks—the limit beyond which machines must not go. If the station is thus separated from the starting ground—which might even be triple in the largest ports—it can clearly be used whatever the direction of the wind may be.

In the center, distinctly separated from the dark-colored tracks and the light grey of the starting ground, there will be the landing ground, always sufficiently wide for an irregular landing. Take, for instance, a large port of, say, 1000 m., 40 metres thereof will be taken on each side for the tracks and 60 metres for the double starting ground, so that there will be a free space of 800 metres.

The landing ground should always be absolutely level, with a thick and regular grassy surface (mown meadow or lawn), rendering it elastic to receive machines at their first contact with the earth, and to break the impact in side landing. Sheets for signals will be stretched out on the meadow, as is already the case at the present time, which signals, however, should preferably be completed with a suitable set of poles made of lead or iron, in order that they may be rolled up, carried away, and spread out in the best possible manner. The signals indicating the direction of the wind should run in black through their centre, in order to distinguish them more easily from the starting ground.

For landing at night it will be necessary to take care that the signal apparatus should not be a direct stumbling-block to the landing itself (and any support projecting from the ground will be a most serious stumbling-block). The signal apparatus should indicate to the pilot not an obstacle to be avoided, but a point to be touched.

Amongst others, a patent has been taken out by the engineer, G. Rabbeno, which fulfils this requirement in an excellent manner. It consists of an electric lamp placed at the bottom of a small cavity, a few decimetres deep, and covered by a strong glass plate flush with the ground.

It is clear that when a certain number of these signals are arranged on the landing ground—for example, like the knots of an octagonal net—the central post can, by means of a simple revolution of the handle, illuminate this or that series along the sides, the diagonals, or whatever it may be, so as to indicate to the pilot the exact spot where he should touch the ground, and in what direction. This will be attained by using two small lamps systematically of different colors in the small terminal cavities of the lines and bands.

In this manner every station will be distinguished at night owing to its well-known lights from long distances similar to maritime ports, and at zenith or a little earlier the pilot will know where to land without fear of falling on top of a colleague.

The great merit of the aforesaid landing beacons is, moreover, that they can also be easily and systematically employed in sea ports by anchoring small buoys in the water.

The block system will enable the harbor master to allot immediate landing places, and, if necessary, to alter them, provided he can see an illuminated square which reproduces the arrangement and the employment of the beacons themselves.

Generally speaking, the landing and starting grounds should always be cleared, that is to say the machines should pass from the tracks on to the starting ground only a few minutes before departure, and on landing machines arriving should at once pass on to the hangars or the respective tracks, according to whether they have completed their journey or are only calling at the port.

For the towing of machines which for some reason cannot use their own means of locomotion, light combustion or electric motor lorries will be of excellent service.

A most important point as regards general efficiency is that the hangars should be divided up according to the function of the sheltered machines, that is, whether they are for public service, private, or military machines, each kind of hangar being well distinguished by special colors, so that every flyer will know at once to which point of the ground he should move on landing, thereby himself and others saving labor. Precedence with regard to facilities for landing should be given to aircraft on public service, and among the latter to those having flown.

It is obvious that all fuel should be kept in a single receptacle or in a series of receptacles perfect from the point of view of safety. By means of motor lorries, or even by a circular moving platform—which is a necessity on large grounds sometimes extending over several hectometres, where people are constantly passing from one end of the ground to the other—it will be very simple to gather the fuel for the machines and carry it to the starting ground.

An air port should be managed exactly as a sea or river harbor, both from the point of view of the object and the arrangements; for aerial navigation, in which control is very difficult, should, even in a higher degree, be subjected to all measures of control by the authorities, however accessory these measures may appear, to obtain the best possible result.

* From *Rivista dei Trasporti Aerei.*

Export Restrictions Lifted

Cotton airplane duck and rubberized silk suitable for use in the manufacture of aircraft are among the articles named by the War Trade Board as having been removed from the Export Conservation List, effective on December 20.

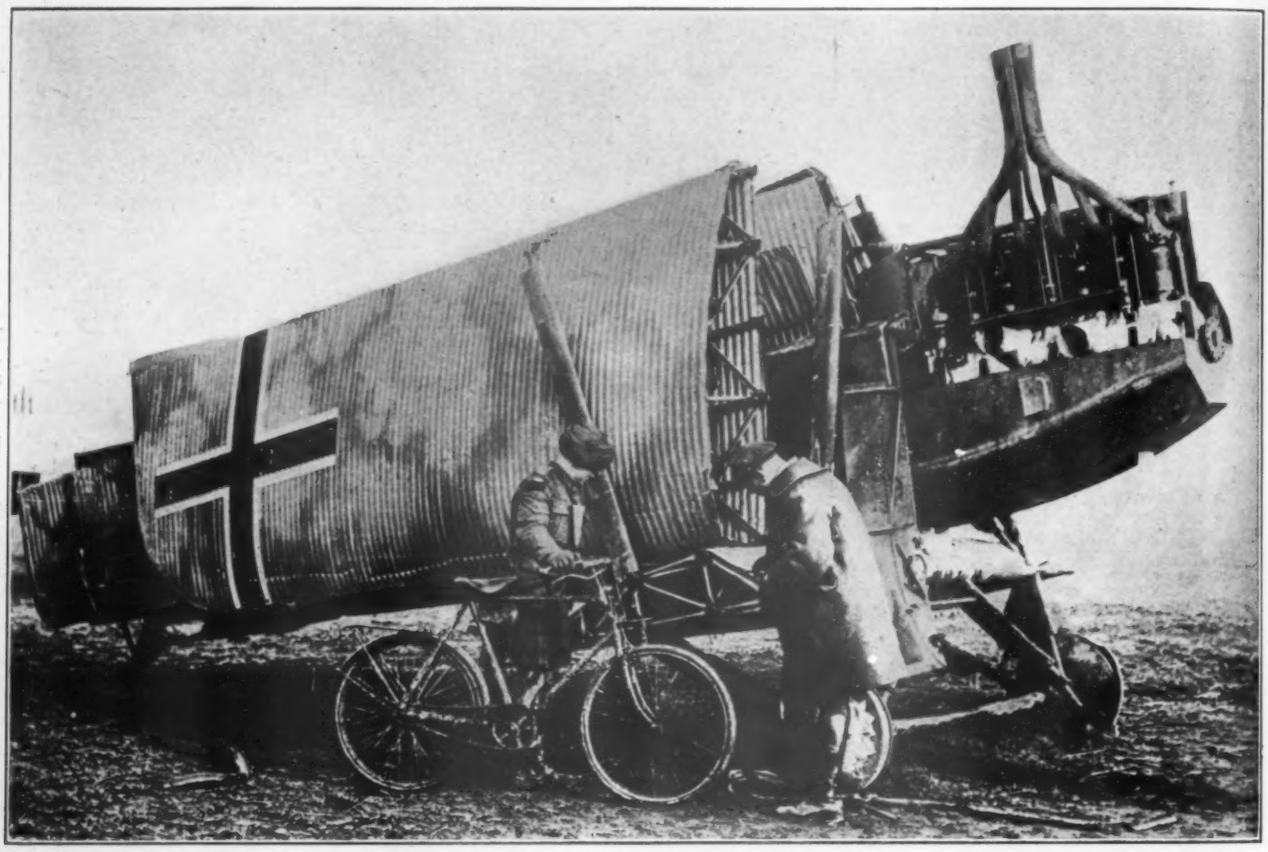
Wood suitable for airscrew blades; veneers for airplane and seaplane bodies, and airplane and seaplane frames are also removed from the Export Conservation List, effective from December 24.

It is also announced that restrictions have been lifted on the importation of mahogany logs and mahogany timber, and that licenses may now be issued freely.

The Fokker-Junkers Armored Biplane

The Fokker-Junkers armored biplane, which is illustrated herewith with the wings folded against the body, is the product of the Fokker-Junkers Works, Ltd., of Dessau, Germany, which was formed in 1917 by the builder of the well-known Fokker pursuit biplanes and triplanes, and Herr Junkers, a manufacturer of heavy-oil engines.

The Fokker-Junkers machine is of considerable interest because it not only represents a recent development in war airplanes, namely, the armored infantry-fighter, or "ground-strafer," but also on account of the aerodynamic and constructional features it embodies. Chief among these is the wireless truss of the wings, the outer wing panels being mounted as cantilevers; and the all-metal construction of the machine, extending to the wings, which are covered with corrugated aluminum. The abnormally deep wing section, reminiscent of recent Fokker practice, is also noteworthy as indicating that the Germans have apparently found the structural advantages afforded by deep aerofoils to outweigh their aerodynamic drawbacks.



(C) *Underwood & Underwood* A Captured Fokker-Junker Biplane *Canadian Official*

Wings—The wings, both upper and lower,, are built up in three panels, which are for each wing of approximately equal transverse dimensions. The upper plane, 50 ft. in overall span, has a center section of 17 ft. and two outer panels of 16 ft. 5 in. each, to which must be added the balanced portion of the ailerons; the lower plane, 36 ft. 2 in. in overall span, has a center section 10 ft., and two outer panels of 13 ft. 1 in. each.

The lower center section fits against the under face of the body, while the upper center section is held in place by N-type steel struts, sloping outwards, the lower ends of which abut against the points of junction of the undercarriage struts. The latter points are braced with steel tubes against the lower body longitudinals; but as the upper junction points of the interplane struts are not braced against the body the strutting has, in front elevation, the shape of a W, with the middle limbs greatly flatted out. This truss affords therefore to the pilot an unusually wide range of vision forward.

The outer panels of both wings are fixed to the center section by screw thread joints, which are fitted to each of the tubular "contour spars" around which the wings are built up. As the outer panels are mounted as cantilevers, these joints entirely support the overhanging portions of the wings.

Wing Construction—The construction of the wings is a unique feature of this machine. Instead of two main spars, as is customary, ten tubular spars are fitted at given intervals along the contour of the aerofoil, four at the upper, and six on the lower face; these tubes, which are 50 mm. in diameter on the upper face of the aerofoil, and 40 mm. at the lower face, are connected with one another by duraluminum web pieces of tubular and U section, the diameter of which varies from 20 to 25 mm. The web pieces are flattened at the ends and riveted to the lugs of collar joints.

The wing covering consists of 0.016 in. aluminum sheet, corrugated parallel with the line of flight, and riveted to the contour spars at about 1½ in. intervals.

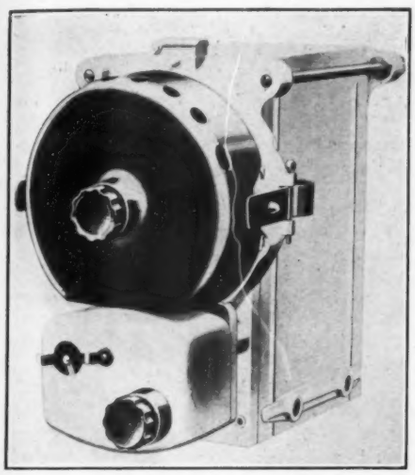
Wing Section—The wings section is remarkable both for its extraordinary depth—about one-sixth of the chord—and because the under face is absolutely flat from the trailing edge to about 10 in. to the leading edge. The maximum depth of both planes diminishes toward the tips, from 16½ in. to 6 in. in the upper wing, and from 12 in. to 4 in. in the lower.

Body—The body is built up of steel longitudinals of L-section, to which 5 mm. armor is riveted from the nose of the machine to back of the after cockpit. Armor is also provided around the engine, a 230 hp. Benz, which it entirely encloses.

Weights—The captured machine upon which the present description is based had the following weight items stencilled on the body: net weight, 1.690 kg.; useful load, 383.5 kg. No data are available on the performances of this machine.

Standardized Magnetos for Aircraft Engines

The Splitdorf Electrical Company is now producing airplane magnetos of the Dixie type which have been in course of development since the outbreak of the war. Before designing this airplane magneto engineers were sent to Europe to familiarize themselves with the types of motor in use by our Allies and the requirements of this most severe of all services for which the gas engine is used. Since the return of these engineers the Splitdorf Company has produced a standardized magneto which has been in service for nearly a year in this country with most gratifying results, while France, Italy and England pronounced it to be the best magneto they have ever seen or tested.



One of the most unique features of this magneto is the standardization of the various models. With sixteen additional parts the same magneto can be converted into any one of seven models, suitable for any existing type of airplane engine, including the Liberty 8 and 12-cylinder engines, with 45 deg. angle between the cylinders.

The following combinations of parts show how these models are constructed from the Dixie 800 Standardized Magneto for 8-cylinder engines as the master unit:

Dixie 400, for 4-cylinder engines—Distributer block, cam.

Dixie 600, for 6-cylinder engines—Distributer block, gears, cam.

Dixie 1200, for 12-cylinder engines—Distributer block, distributer brush, gears.

Dixie 1600, for 16-cylinder engines—Distributer block, distributer brush, gears, cam, rotor, field structure.

Dixie 845, for 8-cylinder, 45 deg. V engines—Distributer block, distributer brush, gears, cam.

Dixie 1245, for 12-cylinder, 45 deg. V engines—Distributer block, distributer brush, gears, cam, rotor, field structure.

The United States Government has in use more than 5000 8-cylinder magnetos of this type, and has adopted the new Dixie as the standard airplane magneto. Since the taking over by the Government of the Bosch plant in Springfield, Dixie magnetos are also being manufactured there, the Splitdorf Company being unable to produce them in sufficient quantities to meet the large demand.

Below are given some comparative results of the tests of a Liberty-12 engine which was fitted in succession with Dixie magneto and generator battery system. According to a statement by the Splitdorf Co., during these tests the engine was kept cooler and ran smoother with magneto ignition than with the battery system, and the spark plugs were also kept cleaner. The duration of the test was 1 hr. 10 min.

	Dixie Magneto Ignition	Generator Battery System
R.p.m.	1527	1477
Fuel Consumption	31.87 gal.	35 gal.
Oil	1.12 gal.	1.87 gal.
Water Temperature	In 72°C. Out 85°C.	In 85°C. Out 100°C.

Although in Europe the magneto has almost exclusively been employed for igniting aircraft engines since the early days of aviation, in this country this ignition system has only recently found a wider application.

Following are some of the aircraft engines which are equipped with magneto ignition:

American—Curtiss, Hall-Scott, Sturtevant, Thomas, Duesenberg, Van Blerck, Hispano-Suiza, Orlo, Aeromarine, Union Gas Engine, Wisconsin, Kirkham, Bugatti, Knox, H. A. Miller, G. V. C.-Gnome, Sterling.

British—Rolls-Royce, Sunbeam, Green, Napier, A. B. C., Beardmore.

French—Renault, Lorrain-Dietrich, Peugeot, Salmson, Clerget, Gnome, Le Rhone, Clerget-Blin, Panhard-Levassor, Hispano-Suiza.

Italian—Fiat, Isotta-Fraschini, Lancia.

German—Mercedes, Maybach, Benz, Opel, Argus.

Canada's Aircraft Industry

Canada's part in winning the war by producing airplanes for the Royal Air Force is little known in this country. At the time the armistice was signed with Germany, Canada was producing 350 training machines of the Canadian Curtiss and Avro types, and eight F-5 type flying boats per month. All these machines were the output of Canadian Aeroplanes, Ltd., Toronto, Ont.

This firm was organized late in 1916 to supply a portion of the demand of Allied countries for flying machines. The whole of the share capital of the company is vested in the Imperial Munitions Board for the British Government. Starting with an advance of a million dollars from the Dominion Government, the Imperial Munitions Board was able to finance the initial operations of the company.

On Feb. 1, 1917, ground was broken for the buildings, and in 45 days 65 per cent of the original plant had been constructed, with 400 operatives at work. By April 30 the company has completed eleven machines. To date the output of the plant has been 3000 machines, valued at $30,000,000.

The company has 2300 employes and the pay roll amounts to $320,000 a month, exclusive of the executive.

Besides these training machines, Canadian Aeroplanes, Ltd., produces the model F-5 flying boat, which was developed along the lines of the Curtiss America for the purpose of bomb-dropping and submarine chasing. This machine has a wing span of 102 ft., an overall length of 49 ft., and a height of 20 ft., and is fitted with two Liberty-12 engines. Its weight, fully loaded, including 450 gal. of gasoline, 1000 lb. of bombs, eight machine guns, and a crew of seven, amounts to 12,900 lb.

Three cockpits are fitted in the hull of the F-5 flying boat. The one at the bow affords accommodation to a gunner provided with twin machine guns; the one amidships seats two pilots, with a radio operator and a mechanic accommodated at the rear, both being under cover; the cockpit situated aft mounts six machine guns, with accommodation for two gunners. At the time the war came to a conclusion it was proposed to substitute for the twin machine guns mounted forward a 12-pdr. Q.F. gun.

That Canada is fully alive to the prospects opened by aircraft in solving problems of rapid transit—problems which the great territorial extension and lack of means of transportation render there particularly acute—is shown by the recent organization of two firms concerned with aeronautics. One is the Aircraft Manufacturing Co., Ltd., of Canada, Montreal, which is allied with Aircraft Manufacturing, Ltd., of London; the other is Aircraft Transport and Travel of Canada, Ltd., Montreal, which will pursue the object of founding and operating aerial services for the conveyance of passengers, goods, and mails throughout Canada and Newfoundland and furnish the Canadian link in the chain of the world-encircling British aerial transport service which Aircraft Transport and Travel, of London, is now organizing with allied French, Italian and other companies.

News of the Fortnight

U. S. Aircraft Strength

With the signing of the armistice, a reliable and intimate view of the United States aircraft program has been made possible in detailed figures authorized by the Production Division of the Bureau of Aircraft Production.

These figures show that up to Nov. 11, 1918, a total of 33,384 planes of all kinds had been ordered; that subsequent to that date orders for 19,628 planes were cancelled, and that on account of the uncancelled orders, or 13,756, there had been shipped up to Dec. 27, 1918, a total of 13,241.

The orders were distributed among manufacturers os follows: Dayton-Wright Airplane Co., 5400; Fischer Body Corp., 6900; Standard Aircraft Corp., 2210; Wright-Martin Aircraft Corp., 50; Liberty Iron Works, 300; Canadian Aeroplane Co., 680; United States Aircraft Corp., 50; Curtiss Aeroplane and Motor Corp., 11,919; Fowler, Howell & Lesser Co., 225; Springfield Aircraft Corp., 1475; St. Louis Aircraft Corp., 650; Thomas-Morse Aircraft Corp., 1150; Breese Aircraft Co., 300; Packard Motor Car Co., 1025; Brewster & Co., 500; Glenn L. Martin Co., 50, and Sturtevant Co., 500.

There was the following distribution of cancellations: Liberty Iron Works, 100; Curtiss Aeroplane & Motor Corp., 7898; Fowler, Howell & Lesser Co., 100; Springfield Aircraft Corp., 850; St. Louis Aircraft Corp., 200; Thomas-Morse Aircraft Corp., 553; Standard Aircraft Corp., 1085; Dayton-Wright Airplane Co., 1896; Fischer Body Corp., 4900; Packard Motor Car Co., 1000; Brewster & Co., 500; Glenn L. Martin Co., 46; Sturtevant Co., 500.

Four companies were unaffected by cancellation orders, viz., Wright-Martin Aircraft Corp., Canadian Aeroplane Co., United States Aircraft Corp., and Breese Aircraft Co.

Long Airship Flight

The naval airship C-1, built by the Goodyear Tire and Rubber Co., recently completed one of the longest service flights an airship has ever made in this country. The C-1 left the naval air station at Rockaway Beach, N. Y., on Jan. 12, and reached Key West, Fla., on Jan. 15, several stops having been made en route.

The vessel is 200 ft. long, has a capacity of 180,000 cu. ft. and is propelled by two 150 hp. Hispano-Suiza engines. Its high speed is 59 m.p.h. The car is 20 ft. long and 10 ft. wide, and contains a spacious cabin, encased with glass to afford protection against the wind and cold. A gun is mounted forward. The complement consists of six officers and men.

Restrictions on Air Transport

According to *The Aeroplane* there will be no passenger or commercial aircraft services between Great Britain and other countries for some time. The consent of the Air Ministry will have to be obtained before commercial aeronautics plans can be materialized, and at the present their consent will not be granted.

The reason for this ban is not a desire to repress or restrict private enterprise, but the whole point is that preparations are not complete for commercial ventures on a large scale. The first difficulty to be solved is a scheme for regulating and controlling air-lines.

For instance, at present there are no clearly defined laws of the air, and to bring the air into the commercial sphere without laws would create chaos. There would quickly be trouble with the Customs authorities of all nations. Fully sufficient legislation would have to be framed to prevent contraband merchandise being carried by aircraft from England to the Continent, and vice versa.

A system of air-customs would have to be instituted, and that alone presents many difficulties. For instance, a pilot wishing to convey contraband could very easily escape detection by landing on an unauthorized spot, on the plea of engine failure, unless a careful check was devised.

At present the navigation of aircraft of every description in the United Kingdom, the coasts, and territorial waters adjoining, is prohibited by law, with the exception of Naval and Military aircraft or airplanes operating within three miles of a recognized aerodrome. That law, it is understood, is likely to stand for the present, but the Air Ministry is now engaged on a scheme of air legislation, which will be an attempt to solve the various problems of future commercial aeronautics.

International Aeronautical Exposition

Hearty co-operation on the part of the War and Navy Departments is assured for the annual aeronautical show which the Manufacturers Aircraft Association is to hold at Madison Square Garden, from February 27th to March 6th. This assurance from Washington means that the exposition will take on the permanent character of a combined effort, uniting National Defense, scientific achievements, and industrial development.

A statement given out by the Manufacturers' Aircraft Association, indicates that the exposition is to have the benefit of Naval and Military cooperation and, while no definite announcement may yet be made with regard to trophy displays, it is believed certain that this exposition which will take rank as the first of a national character, will afford opportunity for the public to inspect for the first time, not only some of the material taken from the enemy abroad, but much of the remarkable equipment which is owned by both the War and Navy Departments.

Co-operation and co-ordination will be fundamentals of the exposition. In the early days of the war, the industry was called upon to aid wherever aid was needed and this show will illustrate to what a remarkable degree this assistance was carried out. The War and Navy Departments still maintain close relationship with the industry and many of the notable exhibits will therefore come through the courtesy and co-operation of the various officials in Washington.

Homologation of Air Records

Data on aviation records is now being collected at all Army flying fields and forwarded to the Homologation Committee of the Air Service Clubs' Association in order to establish present records.

The following are the events being considered for pilots alone and with passengers:

Altitude; duration (non-stop); duration (24 hours); distance (non-stop); distance (24 hours); speed (non-stop), 1 mile, 2 miles, 50 miles, 100, 200, 1000 miles; speed (cross country), 50 miles, 100, 200, 1000 miles; loops (number); water flying (land machines); distance over water, duration over water; climbing time; 6500 ft., 10,000 ft., 15,000 ft., 20,000 ft.

Aviator Crosses Andes

Lieut. Dagoberto Godoy of the Chilean army Dec. 13 crossed the Andes Mountains at their highest point in a Bristol airplane, donated by the British Government. The aviator left Santiago, Chile, and crossed the Cupungato range at an altitude of 19,700 ft., landing at Mendoza, Argentina.

Transatlantic Caproni Building

The Caproni works, at Turin, have nearly finished a gigantic machine in which it will be attempted to fly from Italy to America. The machine is a triplane with engines of 3000 horse-power and ample accommodation for 35 to 40 passengers, for whom cabins and sleeping berths will be available.

Gasoline for the Air Service

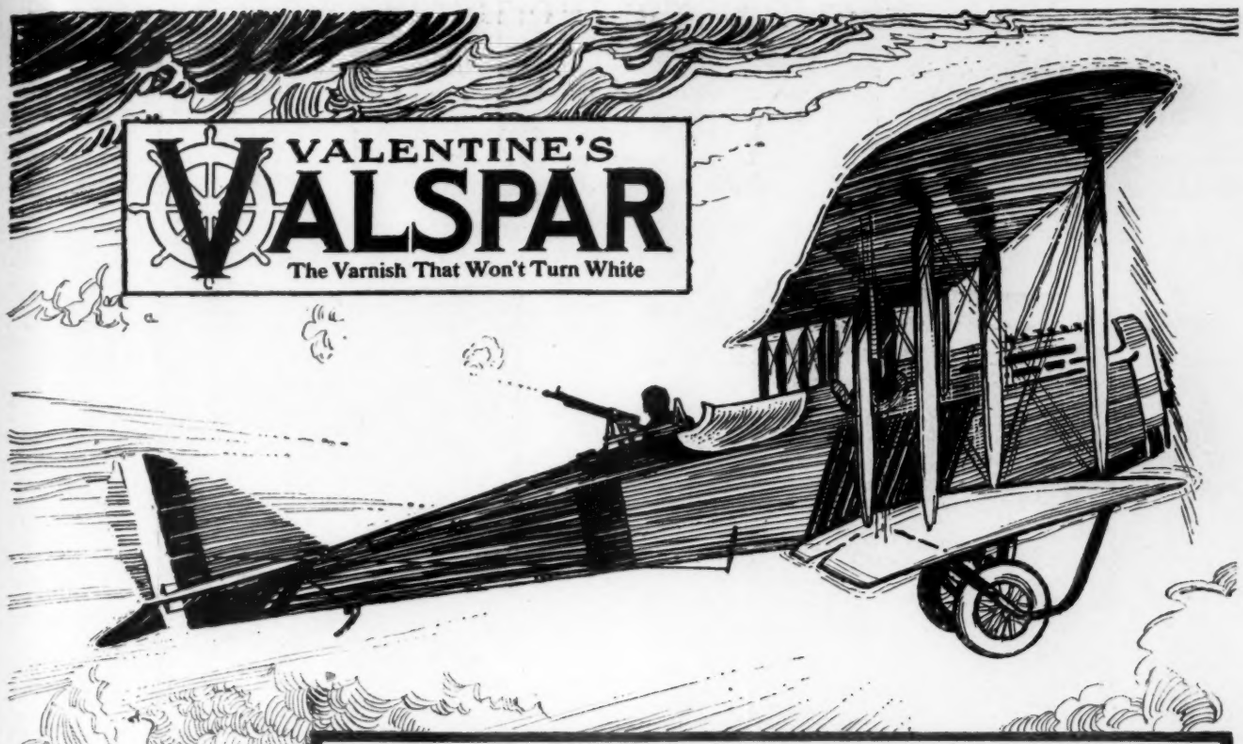
Among the supplies on hand for the use of the Army, as announced in a statement by the Quartermaster General's Department on Dec. 9, are 978,579 gallons of aviation gasoline and 1,075,007 gallons of lubricating oil of all kinds.

Castor Bean Restrictions Off

Special restrictions on the importation of castor beans, issued by the War Trade Board on June 14, 1918, are announced as having been removed.

Hess-Bright Ball Bearings

The Hess-Bright Manufacturing Co., of Philadelphia, Pa., has issued an attractive catalog, which contains beside general information on the use of annular and thrust bearings the principal characteristics of the various types of ball bearings produced by this firm. It is interesting to note that Hess-Bright ball bearings are used in some of the best-known American aircraft engines, such as the Liberty, the Simplex-Hispano-Suiza, the Bugatti, the Curtiss, etc.



VALENTINE'S
VALSPAR
The Varnish That Won't Turn White

The de Havilland 4 with the Liberty engine has been one of the successful associations with America's air program. For reconnaissance and bombing, the British have used the de Havilland 4 with a 300 H. P. Rolls-Royce engine, and the adoption of the Liberty 12 has given the United States superior results in both performances and production.

Valspar *vs.* Vibration—Valspar Wins!

When an airplane equipped with a Liberty motor goes whiz-z-z-z-ing through the sky at 130 to 140 miles an hour, with its machine guns kicking at the rate of 290 a minute—

Talk about *vibration!*

Just a steady Z-n-n-n-n-n of vibrating wires and wings!

Any varnish that is elastic enough to withstand such vibration is *some varnish!*

The experience of the last year of the war proved conclusively that Valspar has the elasticity to withstand the terrific vibration of these powerful planes.

Other varnishes—good varnishes, too—crack from the vibration. And some varnishes that were tried actually flaked off and fluttered to the ground like autumn leaves!

The wonderful elasticity of Valspar Varnish is only *one* of the remarkable qualities that have caused it to be universally accepted as the standard airplane and seaplane varnish.

Our Airplane Department willingly places its experience at the disposal of all airplane and seaplane manufacturers.

To Purchasing Agents and Superintendents of Production: A valuable book full of information on airplane finishing will be sent free on request.

VALENTINE & COMPANY, 456 Fourth Avenue, N. Y.

Largest Manufacturers of High-grade Varnishes in the World—ESTABLISHED 1832

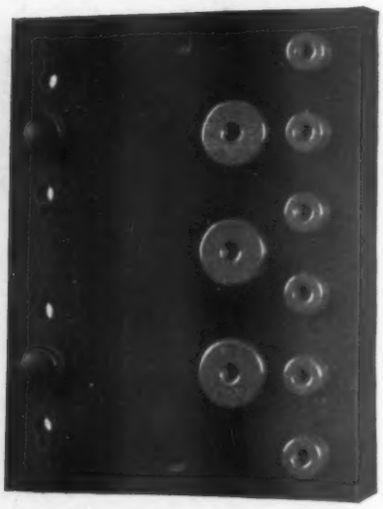
New York Chicago Boston Trade VALENTINES Mark Toronto London Amsterdam

W. P. FULLER & CO., Agents for the Pacific Coast: San Francisco and Principal Pacific Coast Cities

Valentine Products used by the world's leading airplane makers include Valspar Varnish, Valspar Bristol Enamel, Valspar Low Visibility Gray Enamel, Valspar Olive-Drab Enamel, Valspar Black Enamel, Valspar Filler (Wood), Valspar Primer (Metal), Valspar Primer (Wood), Valspar Khaki Enamel, Valspar Aluminum Paint. Dipping, Spraying and Brushing coatings of all kinds, Quick-Drying Insignia Colors.

BAKELITE

REG. U. S. PAT. OFF.



Incorporate Metal Inserts When Moulding

The superior moulding qualities of Bakelite and the fact that metal inserts may be incorporated in a piece when it is being moulded make it incomparable for this class of work.

A "piece" leaves the mould clean, smooth and sharp and with inserts permanently located in exactly the positions desired.

Bakelite will not warp, swell or bloom with age and possesses high dielectric strength. It is homogeneous and non-hygroscopic and is indifferent to heat, water, steam, solvents and most chemicals. It is the ideal moulding material for electrical purposes.

If your work is not in sufficient volume to warrant the maintenance of your own moulding department, there are Bakelite licensees who will do it for you on a contract basis.

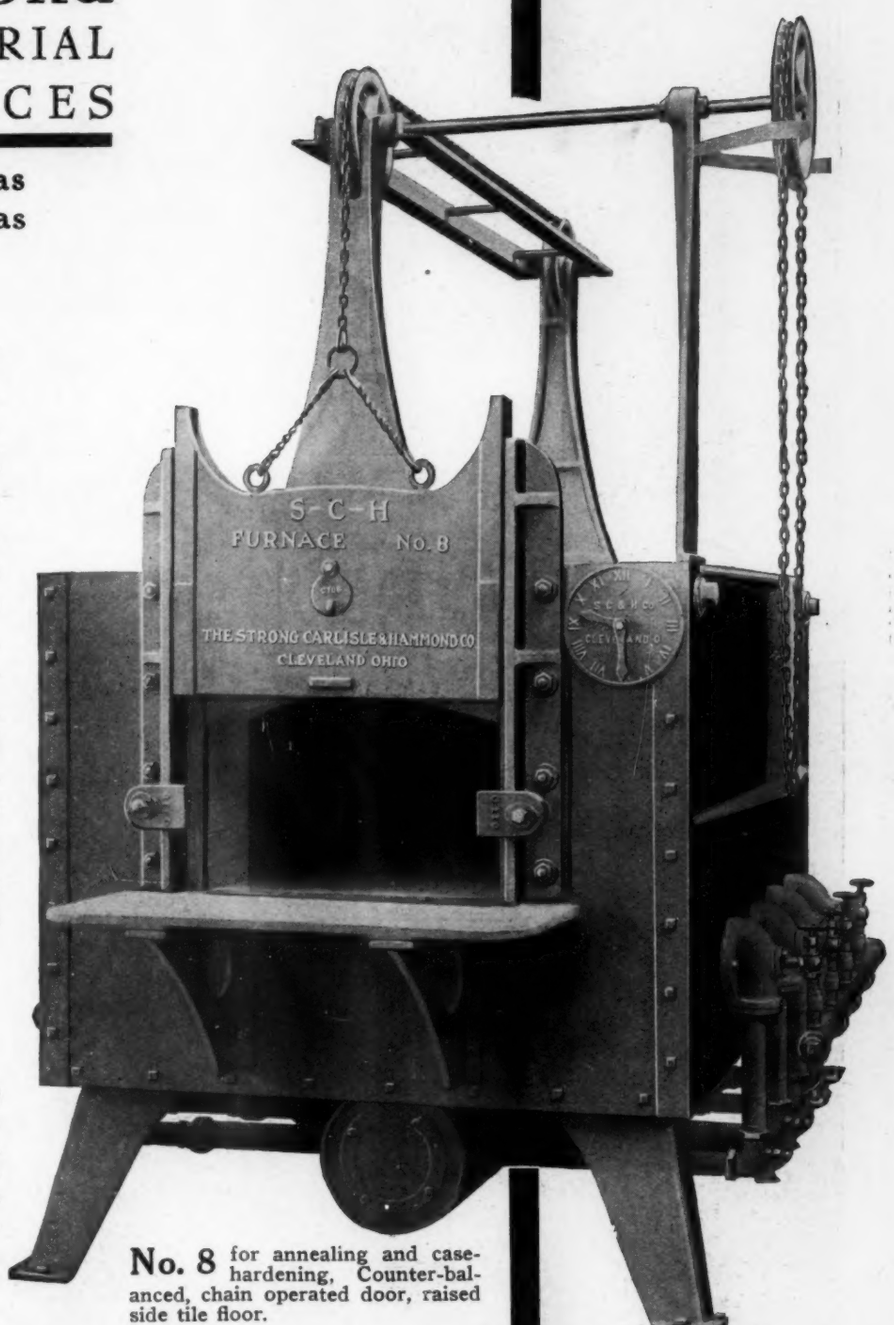
The GENERAL BAKELITE COMPANY, 2 Rector Street, New York, **welcomes inquiries from manufacturers and maintains a research laboratory for the working out of new applications, including those pertaining to flying machines.**

2014 B

Strong Carlisle & Hammond INDUSTRIAL FURNACES

For Oil, Natural Gas or Manufactured Gas

THOROUGHLY practical, from standard shaped tile to burner control, designed to combine absolute accuracy with high capacity, quick to heat—even in temperature—easy to control, operated on oil, natural gas or manufactured gas, every Strong, Carlisle & Hammond furnace is not only designed for its particular purpose, but is equipped with every improvement recommended by actual working experience.



Catalog 8B describes the full line of furnaces and accessories. When you write for it, ask any question you wish about heat-treating. The catalog and advice are both free.

No. 8 for annealing and case-hardening, Counter-balanced, chain operated door, raised side tile floor.

The Strong, Carlisle & Hammond Company

Frankfort Avenue, Cleveland, Ohio

BRANCHES: Boston New York Chicago Philadelphia Detroit Pittsburgh

ERIE STANDARD
AIRCRAFT METAL PARTS

DEPENDABLE SERVICE
QUANTITY-PRODUCTION

Our plant at Erie—the largest of its kind—specializes on AIRCRAFT BOLTS, NUTS and CLEVIS PINS conforming to Government Specifications.

A product as near 100% perfect in quality and machine practice as the human element will permit.

Please request our New York Office to send you copy of our catalogue.

ERIE SPECIALTY CO.
Erie, Pennsylvania
NY Office 8 West 40th St

ACKERMAN LANDING GEAR

Is the latest and highest development in the construction of Landing Gear.

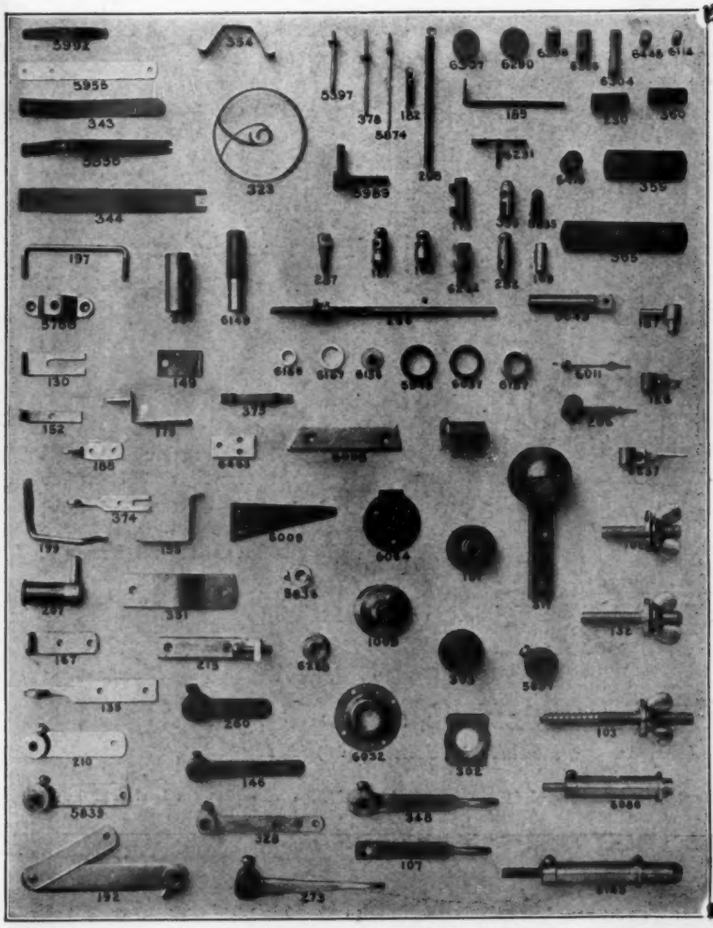
Their SIMPLICITY STRENGTH and SERVICE make them the logical equipment for the Modern Airplane.

Weight 96 pounds complete with tires built for craft weighing 2500 pounds.

WHEELS and LANDING GEARS built for any size machine.

Complete data on Ackerman Equipment is available for Designers and Engineers.

THE ACKERMAN WHEEL COMPANY
542 Rockefeller Building, CLEVELAND, OHIO, U.S.A.



Let Us Quote You On

"SPECIAL" PARTS

We want you to know that one of the largest departments of our business is devoted to the making of all manner of special parts for manufacturers.

Screw Machine and Lathe Work; Die and Sand Castings; Drawn or Stamped Parts; Forgings; Spun Brass Flanges, Ferrules, etc.; Wood Turnings, etc., etc.

Why not send us samples and specifications of your next requirements and we'll try to make it worth your while.

HAMMACHER, SCHLEMMER & CO.

HARDWARE, TOOLS AND FACTORY SUPPLIES

New York, Since 1848 4th Ave. & 13th St.

Luminous Dials

Our dial painting factories are equipped to serve manufacturers of luminous aeronautic instruments promptly and in the best possible manner.

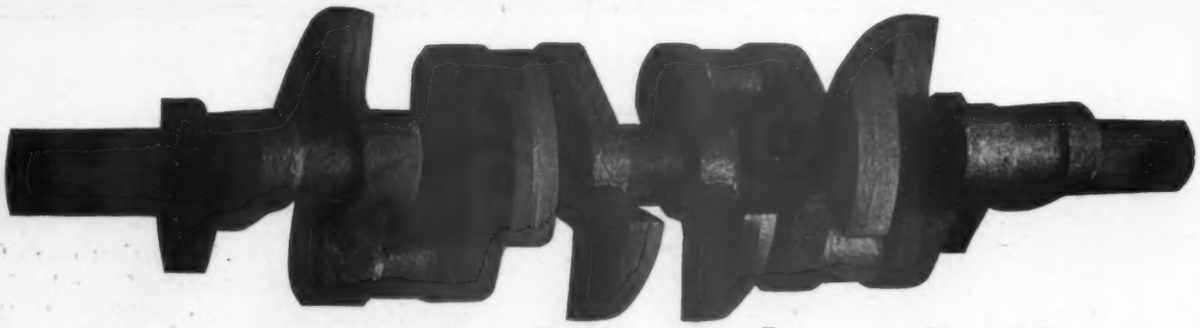
The service is in keeping with the high quality of Luma, the only luminous material we use.

Luma contains pure Radium as its activating agent, no Mesothorium, Radiothorium, Ionium nor Polonium being added.

Estimates and full information upon request.

RADIUM DIAL CO.

GENERAL OFFICES - PITTSBURGH, PA.
LITTLE BLDG., BOSTON - MARSHALL-FIELD ANNEX BLDG., CHICAGO
501 FIFTH AVE., NEW YORK.
DIAL PAINTING FACTORIES - PITTSBURGH - LONG ISLAND CITY - CHICAGO - BOSTON



a counterbalanced aviation crankshaft . . . .

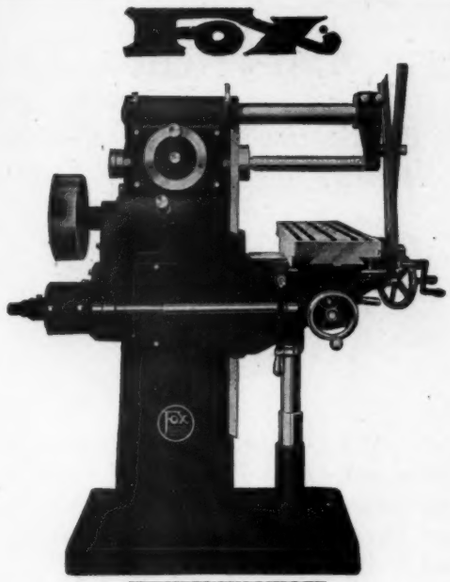
Patented July 10th, 1917

one of the 18 different
models we are now making
for 14 aviation motor companies . . .

reduces vibration and eliminates bearing pressure

We have shipped 46,637 Aviation Crankshafts to January 16, 1919

THE PARK DROP FORGE CO. CLEVELAND, OHIO



No. 2B PLAIN MILLER

Single Pulley Drive

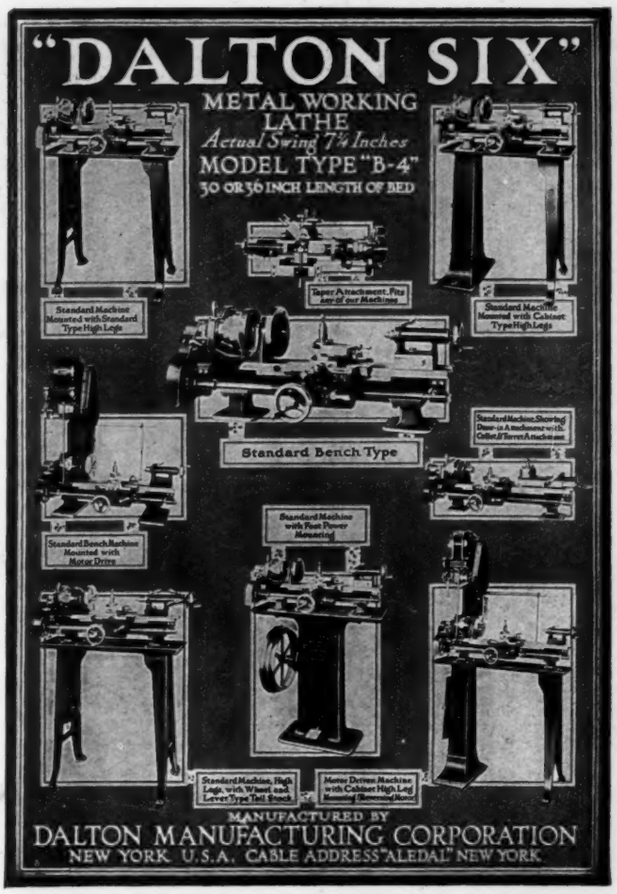
12 changes to spindle speeds
6 changes to each spindle speed
No. 9 taper in spindle.
Table 8½ x 37"

Hardened machine steel gears throughout insure maximum driving power at all speeds.

We also build Universal Millers, Dividing Heads, Vertical Attachments and Vises.

Write for Circular

THE FOX MACHINE COMPANY
1810 W. Gavson St., Jackson, Mich.
Formerly of Grand Rapids, Mich.



Aluminum Company of America
General Sales Office, 2400 Oliver Building
PITTSBURGH, PA.

Producers of Aluminum

Manufacturers of

Electrical Conductors
for Industrial, Railway and Commercial Power Distribution

also

Ingot, Sheet, Tubing, Rod, Rivets, Moulding, Extruded Shapes

also

Litot Aluminum Solders and Flux

CANADA
Northern Aluminum Co., Ltd., Toronto

ENGLAND
Northern Aluminium Co., Ltd., London

LATIN AMERICA
Aluminum Co. of South America, Pittsburgh, Pa.

AJAX Auto and Aero Sheet Metal Company
Manufacturers and designers of
AERO RADIATORS INTAKE and EXHAUST PIPES
F. W. MEYER, 245 West Fifty-fifth Street, New York

DESIGNERS AND MANUFACTURERS

OF PROPELLERS AND PONTOONS

United States Navy Contractors

MATTHEWS BROS. MFG. CO.
Hamilton
MILWAUKEE WIS. U.S.A.

Earnest Consideration Given to
Military and Commercial Production
PROMPT DELIVERIES

Fahrig Anti-Friction Metal

The Best Bearing Metal on the Market
A Necessity for Aeroplane Service

Fahrig Metal Quality has become a standard for reliability. We specialize in this one tin-copper alloy which has superior anti-friction qualities and great durability and is always uniform.

When you see a speed or distance record broken by Aeroplane, Racing Automobile, Truck or Tractor Motor, you will find that Fahrig Metal Bearings were in that motor.

FAHRIG METAL CO., 34 Commerce St., N.Y.

JUST OFF THE PRESS

Aeronautical Engineering and Airplane Design

By *LIEUTENANT ALEXANDER KLEMIN*

Air Service, Aircraft Production, U. S. A., in Charge Aeronautical Research Department, Airplane Engineering Department. Until entering military service in the Department of Aeronautics, Massachusetts Institute of Technology, and Technical Editor of **Aviation and Aeronautical Engineering.** In two parts.

Part 1. Aerodynamical Theory and Data

Modern Aerodynamical Laboratories
Elements of Aerodynamical Theory
Sustention and Resistance of Wing Surfaces
Comparison of Standard Wing Sections
Variations in Profile and Plan Form of Wing Sections
Study of Pressure Distribution
Biplane Combinations
Triplane Combinations—Uses of Negative Tail Surfaces
Resistance of Various Airplane Parts
Resistance and Comparative Merits of Airplane Struts
Resistance and Performance
Resistance Computations—Preliminary Wing Selections

Part 2. Airplane Design

Classification of Main Data for Modern Airplanes; Unarmed Land Reconnaissance Machines; Land Training Machines
Land Pursuit Machine; Land Gun-Carrying Machine; Twin-Engined All-round Machine
Estimate of Weight Distribution
Engine and Radiator Data
Materials in Airplane Construction
Worst Dynamic Loads; Factors of Safety
Preliminary Design of Secondary Training Machine
General Principles of Chassis Design
Type Sketches of Secondary Training Machine—General Principles of Body Design
Wing Structure Analysis for Biplanes
Notes on Aerial Propellers

Price, Postpaid, in the United States, $5.00 Net

THE GARDNER-MOFFAT COMPANY, Inc., Publishers
22 East 17th Street, New York City

King Sewing Machine Company

BUFFALO, N. Y.

Large producers of screw machine products, especially aeroplane bolts, nuts, clevis pins, clevises and universal joints.

Contractors to Bureau of Aircraft Production. Government specifications and inspection.

We solicit your inquiries.

TRADE YALE MARK

For Emergency Hoisting

or for general work the YALE Spur-Geared Chain Block is equally adaptable.

Easily operated, SAFE with any user, speedy and perfectly reliable under all service conditions, the YALE Spur-Geared Chain-Block is a Universal Hoist.

'From-Hook-to-Hook-a-Line-of-Steel'

Catalog 18D tells about the YALE Steel Chain and the YALE Safety-Hook—exclusive features.

For Sale by Machinery Supply Houses.

For Factory Locking Equipment use a YALE Master-Key System. Write for particulars

The Yale & Towne Mfg. Co.

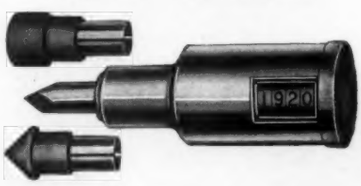
9 East 40th Street **New York City**

You can dispense with the preliminary block test—

by finding the R.P.M. of airplane motors, prior to the final tachometer rating, with a

Veeder

SPEED COUNTER



Simply hold the Veeder against revolving propeller shaft; apply slight pressure the moment you start timing; release pressure when minute is up. Clutch starts or stops recording mechanism instantly, giving accurate readings without use of stop-watch. Price, $3.00.

Veeder Counters for recording the production of machines are standard for all industrial purposes. Write for booklet.

The Veeder Mfg. Co.

56 Sargeant St., Hartford, Conn.

TURNBUCKLES

of the

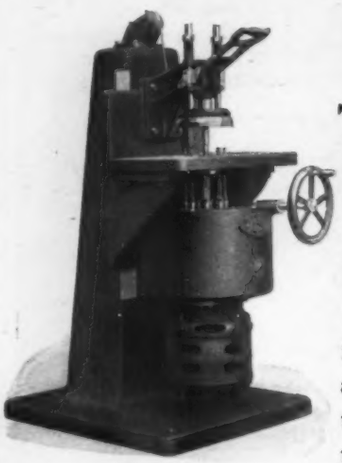
Highest Quality

to Meet the Most Exact Requirements

Standard Turnbuckle Company

CORRY, PA.

New York Office: Woolworth Building



Yates

Type C-20 Propeller Boring Machine

A recently perfected machine for automatically boring the necessary holes in the modern aeroplane propeller hub in one operation. Extremely durable, compact, and efficient. Does absolutely accurate and uniform work. Specially designed so that no oil can get on and injure the stock. Either belt or direct motor drive.

Send today for complete details

P. B. Yates Machine Co.
BELOIT, WISCONSIN, U.S.A.

ROME AERONAUTICAL RADIATORS

Developed from years of experience in building all types of radiators.
They possess every feature and qualification necessary for a high grade product.

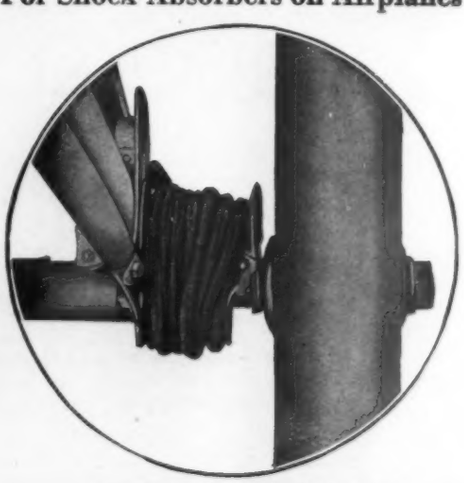
STRONG
EFFICIENT
DURABLE

Used on the best American flying machines.
Our engineering department is at your service.

Rome-Turney Radiator Company
Rome, N. Y., U. S. A.

Elastic Aviation Cord

For Shock Absorbers on Airplanes



We originated and have developed this special heavy elastic cord for airplane shock absorbers.
We are the largest manufacturers in the world of Heavy Elastic Cord and owing to our factory capacity we can make prompt deliveries.

Samples on request

J. W. WOOD ELASTIC WEB CO.
FACTORY: STOUGHTON, MASS.

OFFICES

46 East 17th Street . . . . . New York
181 W. Lake Street . . . . . Chicago
32 St. Peter Street . . . . . Montreal, Canada

FUEL LEVEL GAGES

This cut shows our Model 51 Gage which is standard on practically all type of military training machines.

Other types of gages in large quantities are "doing their bit" as part of the equipment of English Government Warplanes.

SPECIAL TYPES DESIGNED FOR YOUR ESPECIAL NEEDS.

BOSTON AUTO GAGE CO.
8 WALTHAM STREET, BOSTON, MASS.

STIMPSON-RIVETS

REGULAR SIZES

WE MAKE SCREW HEAD NAILS AND RIVETS FOR EVERY PURPOSE.
EYELETS, HOOKS, GROMMETS AND WASHERS FOR SHOES, SHELTER TENTS, CORSETS, LEGGINS, MAIL BAGS.

SPECIAL TO ORDER

70 FRANKLIN AVENUE 70 BROOKLYN, NEW-YORK

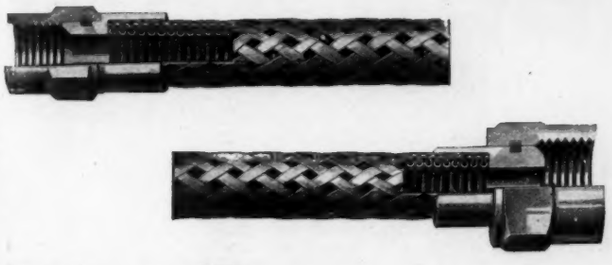
The New "PARAGON" Plant

Nothing too large; nothing too small. Capacity up to 400 Propellers per day. The Peace-time Paragons are all designed or approved by Spencer Heath. This absolutely guarantees not workmanship alone, but SAFETY and PERFORMANCE above all else. Recent official tests by the Royal Air Forces in Canada show 33⅓ per cent faster climbing and 3⅔ per cent greater speed than nearest of three competing designs.

For SAFETY and EFFICIENCY, depend upon the

AMERICAN PROPELLER & MFG. CO.

Baltimore, Md., U. S. A.



Tite flex

REG U S PAT OFF

Another Advance in Aeroplane Reliability

Titeflex adapts itself to any curve, is protected by a braided metal armor, has the lasting tightness of an all-metal, cold-welded structure, is quickly applied with any specified couplings ready for installation, and should remain free from maintenance troubles for the life of the metal. There are no interior parts to disintegrate and clog carburetor or cut the bearings.

We also make interlocked tubing for hot air stoves, exhaust pipes, wiring conduits, etc.

TITEFLEX METAL HOSE CORPORATION

Badger Avenue and Runyon Street Newark, N. J.

1

FOXBORO

QUALITY INSTRUMENTS FOR AIRPLANES

Airspeed Indicator or Buoyancy Meter
Gasoline Level Indicator
OIL PRESSURE GAUGE

Indicating Dial Type Thermometer for circulating oil and water
AIR PRESSURE GAUGE

The Foxboro line also includes many different types of indicating and recording gauges and thermometers designed for all sorts of conditions and purposes.

THE FOXBORO CO., Inc., FOXBORO, MASS., U.S.A.

NEW YORK CHICAGO PITTSBURGH PHILADELPHIA ST. LOUIS
SAN FRANCISCO BIRMINGHAM, ALABAMA PEACOCK BROS., MONTREAL

SEAMLESS STEEL TUBING

Large Stock on Hand

Prompt Mill Deliveries

COLD DRAWN SHAFTING AND SCREW STEEL

Eastern Distributor: BORDENTOWN STEEL & TUBE CORP.

JULIUS BLUM & COMPANY **510-512 West 24th Street, New York, N. Y.**

Branches: Boston, Chicago, Philadelphia

PHILBRIN
DUPLEX IGNITION
—with a second system to spur the motor to super-service.

COMBINES two separate and distinct systems in one—a Single Spark System, most economical of gas, and offering vastly increased power. A Secondary or High Frequency System which delivers to each cylinder a stream of a thousand sparks a second—overcomes abnormal conditions, such as foul spark plugs, poor fuel, poor carburetion, and cold cylinders—offers 100% Assurance against ignition failure.

Easy to install, moderate in price. Descriptive catalogues and our special sales proposition on request.

PHILIPS-BRINTON COMPANY

501 So. Broad Street Kennett Square, Pa.

"Airplane Propellers"

The first complete book in catalogue form ever published in the world

It describes over three hundred airplane propellers of the most practical types and twenty helicopter propellers; also contains laboratory experiments on helicopter propellers and much useful data on general air dynamics.

Price $1.50 Prepaid

JACUZZI BROTHERS

2034 San Pablo Avenue Berkeley, Calif.

DOEHLER
BABBITT-LINED BRONZE
BEARINGS

have been used for years with the utmost success by the leading motor manufacturers in the automobile and airplane industries.

DOEHLER DIE-CASTING CO.

MAIN OFFICE AND EASTERN PLANT
BROOKLYN. N.Y.

WESTERN PLANT TOLEDO. OHIO. NEW JERSEY PLANT NEWARK. N.J.

Also Die-Cast Babbitt Bearings, Die-Castings in Brass & Bronze Aluminum and White Metal Alloys

Quality Springs

Specialists in Heat-Treating Vanadiums

New York Wire & Spring Company

586 Washington Street, New York

CAPITAL INTERNAL GRINDER **STAMPINGS** **JIGS TOOLS DIES**

WE realize *in air* or *at sea* there should be *no faulty* material. All machine parts must be made *right* and perform their functions *properly*, hence we have equipped our new plant to turn out work of the highest quality. We offer our facilities to you and trust we may be of service.

Will you give us a trial?

LANSING STAMPING & TOOL CO.

LANSING, MICHIGAN

Just Published

THE NEW CONQUEST OF THE AIR

By A. Lawrence Rotch and Alexander Klemin

The Boston Post says: "Here is a brief but adequate history of man's attempts to fly and his final conquest of the air."

The Boston Herald says: "Professor Rotch's volume is a valuable study of aeronautics."

Your check or money order for $1.50 brings the book to your door postpaid.

MOFFAT, YARD & COMPANY

31 Union Square West New York City

Tycos

Aviation Barometer

Made in U. S. A.

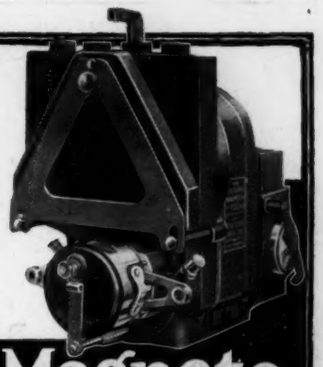
Write for Information

Taylor Instrument Companies

Rochester, N. Y.
U. S. A.

For over sixty years makers of scientific instruments of superiority

Seven out of ten American airmen have proved the Berling's worth.



Berling Magneto

WORTH MORE DOES MORE

ROEBLING

AIRCRAFT WIRE, STRAND AND CORD

Send for Aircraft Catalogue—A-256

JOHN A. ROEBLING'S SONS CO., TRENTON, N. J.

CARBURETOR

EVERY Liberty Aircraft Engine built is equipped with Zenith Liberty Carburetors—*the reason is clear to Zenith users.*

Zenith Carburetor Co.

New York DETROIT Chicago

JACUZZI BROTHERS

2034 San Pablo Ave., Berkeley, Cal., U. S. A.

Propellers of every description for Airplanes, Dirigible Balloons, Helicopters, Ice Sleds, etc., for any type of motor, including Motorcycle Motors, Ford Motors, Curtiss, Hall-Scott, Hispano-Suiza, Liberty Twelves, etc.

Get our prices before ordering. Highest efficiency guaranteed

PIONEERS IN THE MANUFACTURE OF PROPELLERS

ESTABLISHED 1910

We carry a large stock for immediate delivery.
Contractors to United States Government.

Wisconsin

CONSISTENT

AEROPLANE MOTORS

are correctly designed with the highest quality materials and workmanship.

Write for catalog of 6 and 12 cylinder models.

WISCONSIN MOTOR MFG. CO.

Station A. Dept. 338. Milwaukee, Wis., U. S. A.

For Safety:—

RESISTAL

Non-Shatterable

GLASS

used in Goggles, Windshields and wherever glass may break.

STRAUSS & BUEGELEISEN

438 BROADWAY - - NEW YORK CITY

Recharges Itself in 30 Seconds

A noteworthy feature of this compressed air starter is that it replenishes its energy in less time than any other starting system in existence.

Model D

The "Perfect Starter"

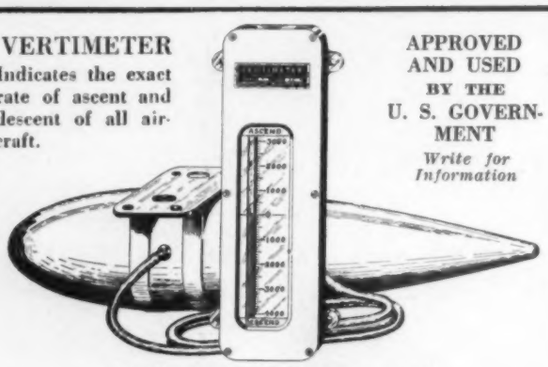
No alteration in motor or other gear reduction is needed for attachment. When the starter is not in use, the motor is left entirely free. Interference is impossible. "Model D" for 150 H.P. engines weighs 55 lbs., and "Model C" for 250 H.P. engines, 65 lbs. Tested and approved by U. S. and Foreign Governments.

Send for Free Booklet

THE MOTOR-COMPRESSOR CO., Newark, N. J., U.S.A.

VERTIMETER

Indicates the exact rate of ascent and descent of all aircraft.



APPROVED AND USED BY THE U. S. GOVERNMENT

Write for Information

AERONAUTICAL INSTRUMENT CO.

32 East 23rd Street New York City

PETERS SOLDER

The quickest, strongest, most efficient and most economical crankcase repair on the market, ABSOLUTELY GUARANTEED TO BRAZE BROKEN ALUMINUM PARTS IN SUCH A MANNER AS TO MAKE THE BRAZED PORTION ABSOLUTELY BREAK-PROOF. Does not require intense fusing heat, thus saving texture of metal.

Write for full details.

ALUMINUM BRAZING SOLDER CO.
Montgomery Bldg.,
Chester, Pa., U. S. A.

ALUMINUM BRAZING

FEDDERS RADIATORS

Our Genuine Honeycomb type has been standardized by the U. S. Government for use on all its Airplanes.

FEDDERS MFG. CO., INC.
Buffalo, N. Y.

THE "WARNER" STICK CONTROL IS ENDORSED BY AMERICA'S LEADING PILOTS.

(3 holding World's Records)

Operated with either hands or knees

WM. DESHLER WARNER
Patentee and Mfgr.
8 E. Broad St. Columbus, O.

Classified Advertising

10 cents a word, minimum charge $2.00, payable in advance. Address replies to advertisements with box numbers, care of AVIATION AND AERONAUTICAL ENGINEERING, 120 West 32d Street, New York.

AIRPLANES—1 to 6 passenger; aeronautical motor 30 to 300 hp. Lowest prices. State your needs. Send for lists AN. Aero Exchange, 38 Park Row, New York City.

AERONAUTICAL ENGINEER with three years' experience desires connection with reliable party. Address Box 104.

JUST RELEASED from Air Service. Desire testing or instructing work with reliable company. Have approximately eight hundred hours divided equally to testing and instructing Kelly Field. State salary offered. Warren P. Kite, 785 South Street, Springfield, Mo.

FOR SALE—Large stock of Airplane Material of every description. Standard Aircraft Corporation, Elizabeth, N. J.

AERONAUTICAL, MECHANICAL ENGINEER. Nine years' experience, recently returned from abroad, experienced on over 25 types of airplanes, familiar with all technical and practical details of airplane design and construction. Can superintend highest development. Highest recommendations. Desires connection with reliable firm. Address Box No. 103.

MILITARY AVIATOR, Lieut. U. S. Army, leaving service, honorable discharge. Pilot and combat instructor, two years' flying experience, is open for engagement as Test Pilot, Instructor or as representative aeroplane corporation. Has knowledge of Spanish customs and conditions in South America. Box 102.

INDEX TO ADVERTISERS

A

Ackerman Wheel Co. 42
Aeronautical Instrument Co. 52
Ajax Auto & Aero Sheet Metal Co. 45
Aluminum Brazing Solder Co. 52
Aluminum Co. of America 45
American Bronze Corp. 15
American Lead Pencil Co. 16
American Propeller & Mfg. Co. 49

B

Blum, Julius, & Co. 50
Boeing Airplane Co. 12
Boston Auto Gage Co. 48

C

Cold Light Mfg. Co. 16
Curtiss Aeroplane & Motor Corp. 56

D

Dalton Manufacturing Corp. 45
Doehler Die Casting Co. 50

E

Ericsson Mfg. Co. (Berling Magnetos) 51
Erie Specialty Co. 42

F

Fahrig Metal Co. 46
Fedders Mfg. Co. 52
Foxboro, The, Co. 49
Fox Machine Co. 45

G

General Bakelite Co. 40
Goodyear Tire & Rubber Co. 13
Gurney Ball Bearing Co. 55

H

Hall-Scott Motor Car Co. 3
Hammacher, Schlemmer & Co. 43
Hartzell Walnut Propeller Co. 7

J

Jacuzzi Bros. 50-51

K

King Sewing Machine Co. 47

L

L. W. F. Engineering Co. 4
Lansing Stamping & Tool Co. 50
Loening, Grover Co. 14

M

Manufacturers' Aircraft Assn. 5
Martin, Glenn L., Co. 2
Matthews Bros. Mfg. Co. 46
Moffat, Yard & Co. 50
Motor-Compressor Co. 52

N

New Departure Mfg. Co. 18
New York Wire & Spring Co. 50

P

Park Drop Forge Co. 44
Philips-Brinton Co. 50
Pratt & Lambert 54

R

Radium Dial Co. 44
Roebling's, John A., Sons Co. 51
Rome-Turney Radiator Co. 48

S

Sperry Gyroscope Co. 8
Standard Aircraft Corp. 9
Standard Turnbuckle Co. 47
Stimpson, Edwin B., Co. 49
Stone Propeller Co. 51
Strong, Carlisle & Hammond Co. 41
Strauss & Buegeleisen 52

T

Taylor Instrument Companies 51
Thomas-Morse Aircraft Corp. 43
Titeflex Metal Hose Corp. 47

U

Union Gas Engine Co. 10
United Aircraft Engineering Corp. 6

V

Valentine & Co. 39
Veeder Mfg. Co. 47

W

Warner, Wm. Deshler 52
Wisconsin Motor Manufacturing Co. 51
Witteman-Lewis Aircraft Co. 51
Wood, J. W., Elastic Web Co. 48
Wyman-Gordon Co. 17

Y

Yale & Towne Mfg. Co. 47
Yates, P. B., Machine Co. 48

Z

Zenith Carburetor Co. 51

Armoring the Aeroplane Against the Elements!

Reproduced by Courtesy Curtiss Aeroplane & Motor Corp.

TO give the aeroplane a weatherproof armor that would resist the elements *under all conditions*, was a problem brought out forcibly by the severe service demanded of these ships of the air during the war.

Wood, fabric and metal could not be satisfactorily protected by any one varnish, so we concentrated on the development of varnishes especially adapted to the needs of aircraft manufacture and the result is

PRATT & LAMBERT AEROPLANE VARNISHES

The high regard in which these products are held is evidenced by the thousands of barrels of P&L Aeroplane Varnishes used on aeroplanes for the U. S. Government and the Allies.

Expressions received from aeroplane manufacturers not only point to the high quality of Pratt & Lambert Aeroplane Varnishes, but also comment enthusiastically upon the excellent service resulting from constant effort on our part to deliver promptly, even under the stress of wartime conditions.

Pratt & Lambert Aeroplane Varnishes include air-drying and baking varnishes; enamels and finishes for brushing, spraying and dipping. We offer to all aeroplane manufacturers the benefit of unusual experience and service in this work.

Check off the following in which you are interested and mail this page to us.	
	Impermalin — *a waterproof varnish for wood and fabric*
	Naval Aeronautical Enamel *all colors*
	Wing Enamel, *all colors*
	Liquid Wood Filler
	Propeller Varnish
	Metal Fittings Lacquer

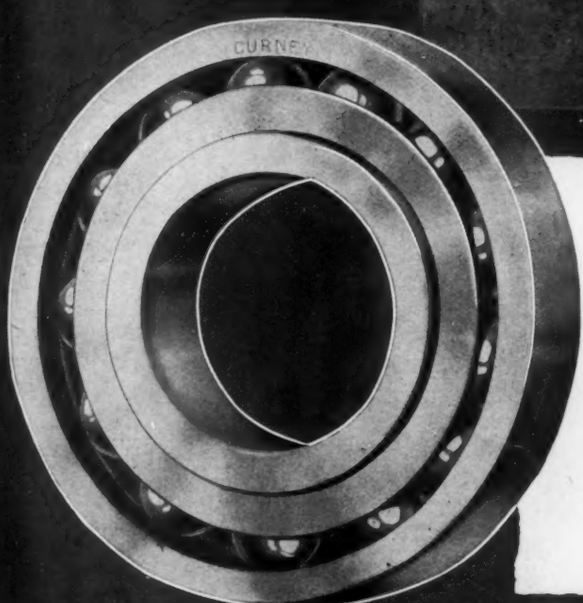
PRATT & LAMBERT-INC.

Pioneers in the Manufacture of Aeroplane Finishes

134 TONAWANDA ST., BUFFALO, N. Y.

NEW YORK — FACTORIES BUFFALO BRIDGEBURG, ONTARIO — CHICAGO

GURNEY
BALL BEARINGS



THE VICTORS' RETURN

Keen after-the-war competition demands power-economy, best secured by use of ball bearings that carry both radial and thrust loads on a single row of balls (promoting simple and economical design),—that take the maximum load for size of bearing,—that allow maximum number and size of balls,—that utilize the full load capacity of each ball, due to close and highly perfected race contour.

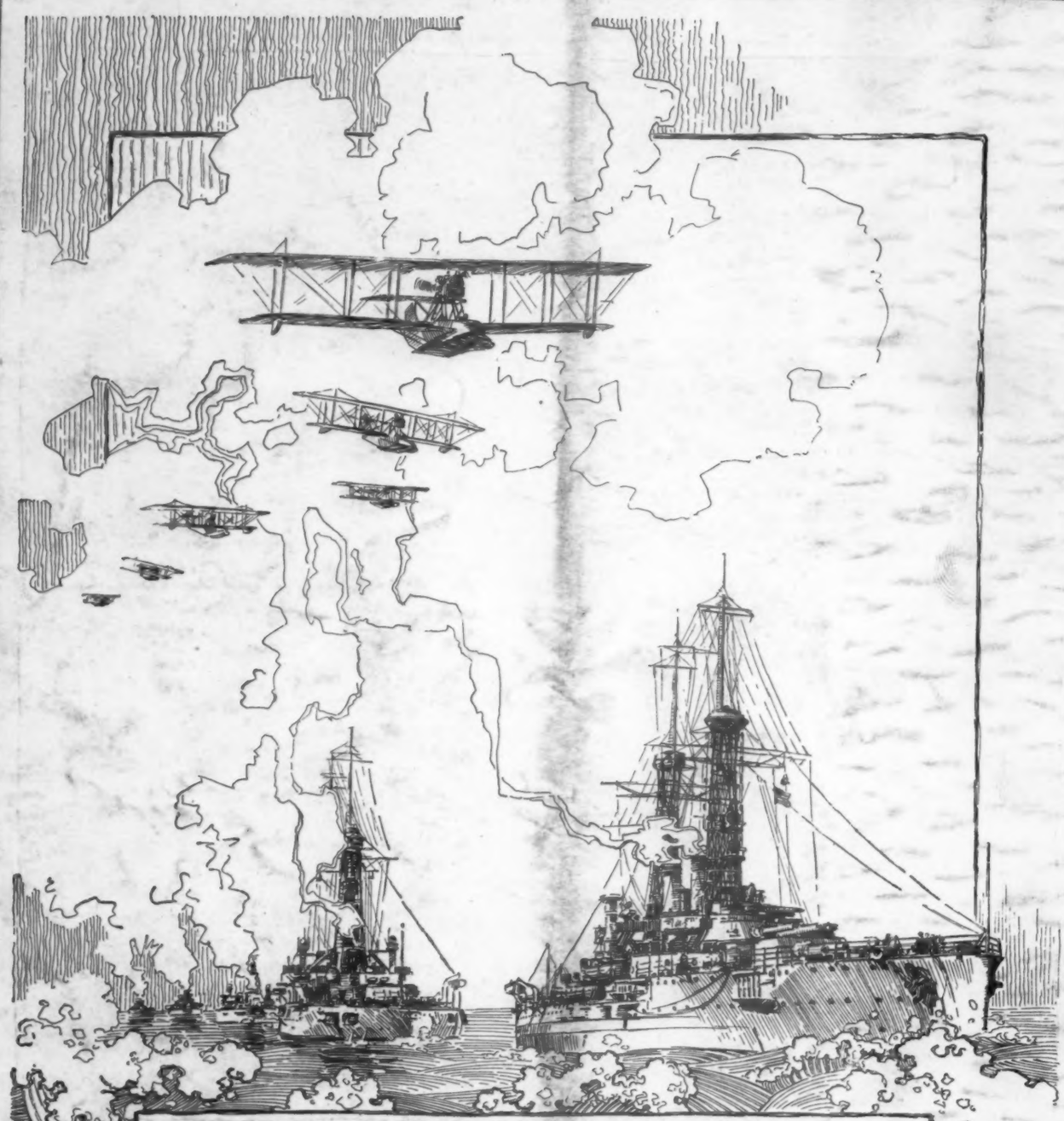
Our Engineering Department is at your service—Write

GURNEY BALL BEARING CO.

Conrad Patent Licensee

Jamestown N. Y.

299



The efficiency of the Curtiss Flying Boats and the patriotic enthusiasm of Curtiss men who have made them, will stand as permanent expressions of true Americanism in the history of the Great War.

V.Q. Martin

CURTISS AEROPLANE & MOTOR CORPORATION, Buffalo, N. Y.